MERRIMACK RIVER BASIN

NELSON, NEW HAMPSHIRE

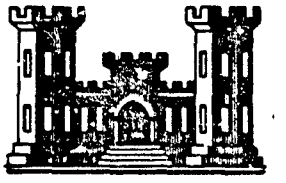
NUBANUSIT LAKE DAM

NH 00339

NHWRB 166.04

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

AUGUST 1978

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NH 00339	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Nubanusit Lake Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PEHIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE August 1978 13. NUMBER OF PAGES 65
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection c Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Nelson, New Hampshire
Nubanusit Brook

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is an earth embankment 279 ft. long and a height of 16 ft. The dam in fair condition at the present time. Deficiencies in the areas of inadequa spillway capacity, deteriorated earth embankments and some operational aspect require near-term attention. It is intermediate in size with a significant hazard potential. THe spillway is considered inadequate and the overtopping could result in the failure of the dam.

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:

NEDED

Honorable Meldrim Thomson, Jr.
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

NOV 30 1978

Dear Governor Thomson:

I am forwarding to you a copy of the Nubanusit Lake Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Mr. John J. Colony, c/o Harrisville Designs, Harrisville, New Hampshire 03450.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NUBANUSIT LAKE DAM

NH 00339

MERRIMACK RIVER BASIN
NELSON, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification No.: NH 00339

NHWRB No.: 166.04

Name of Dam: NUBANUSIT LAKE

Town: Nelson

County and State: Cheshire, New Hampshire

Stream: Nubanusit Brook

Date of Inspection: 14 June 1978

BRIEF ASSESSMENT

Nubanusit Lake Dam is an earth embankment 279 feet long and with a maximum height above the downstream channel of 16 feet. The embankment incorporates a gate house which contains an 11 foot long granite spillway and the controls for two 4' x 5' flood gates; each 4' x 5' gate contains an independently operated, 2' x 3' spiller gate at its base. Initial construction took place in 1861 with a major alteration and expansion around 1896. No original plans are available. The dam discharges into Nubanusit Brook which flows through the mill village of Harrisville 2 miles downstream.

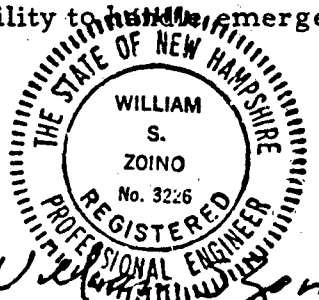
The drainage area is 6.1 square miles of heavy, steeply sloping forest. The dam's maximum impoundment of 7740 acre-feet places it in the INTERMEDIATE size category. The hazard potential classification of SIGNIFICANT derives from the extensive property damage, but unlikely loss of life, expected downstream in the event of failure.

The dam is in FAIR condition at the present time. Deficiencies in the areas of inadequate spillway capacity, deteriorated earth embankments and some operational aspects require near term attention. Two areas of low volume seepage on the downstream slope warrant regular monitoring on a monthly basis. Recommendations herein should be implemented by the owner within 1 to 2 years of receipt of the Phase I Inspection Report.

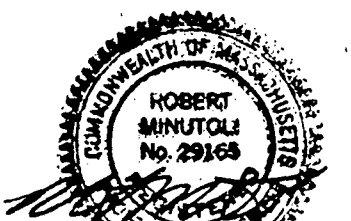
Based on size and hazard classification in accordance with Corps' guidelines, the Spillway Test Flood (STF) ranges between the PMF (Probable Maximum Flood) and 1/2 PMF. The selected test flood results in an outflow of 2370 cfs (390 cms) assuming that the flood gates are opened when the low point in the dam begins to be overtopped. This flow will overtop the main crest of the dam by 1.15 feet. If the flood gates are not opened the overtopping is increased to 1.45 feet. The maximum capacity of the spillway and flood gates without any overtopping of the dam, including the low spot, is approximately 850 cfs. The spillway is therefore considered inadequate and the overtopping could result in the failure of the dam.

Further studies by a consulting engineer should be undertaken to determine what alternative measures may be necessary to correct the inadequate discharge capacity.

Operationally, the dam requires at least monthly monitoring of the two seepage points noted, increased attention to the condition of the embankment in terms of repair of erosion, additional riprap and removal of trees, repair of the upstream wingwalls and clearing of the immediate downstream channel. The installation height of the gage requires verification and some minor changes in the normal operational procedure will improve the owner's ability to handle emergencies.



William S. Zoino, P. E.
NH Registration 3226



Robert Minutoli, P. E.
Mass. Registration 29165

This Phase I Inspection Report on Nubanusit Lake Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Charles G. Tiersch

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

Fred J. Ravens Jr

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

Saul Cooper

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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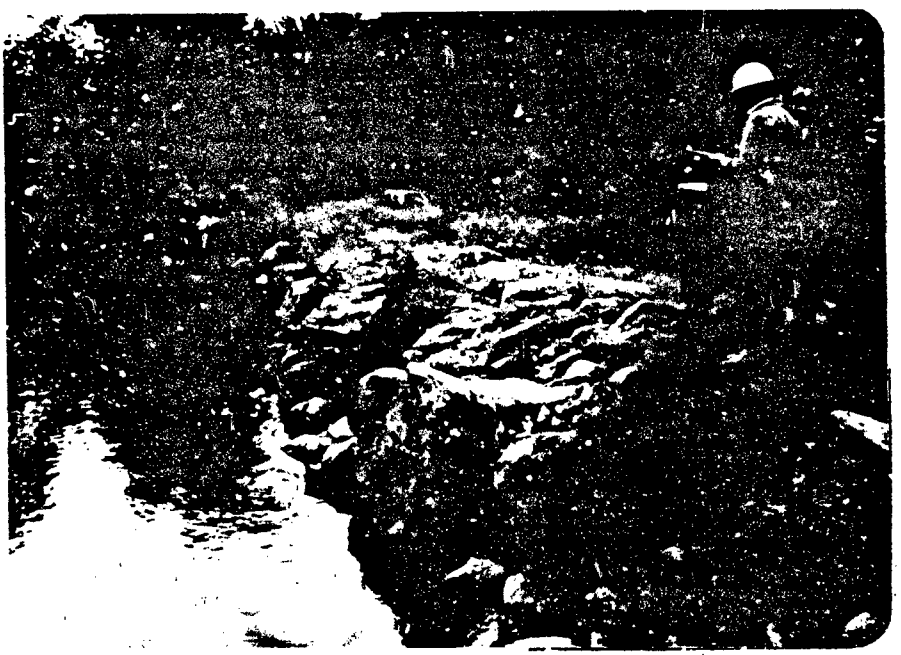
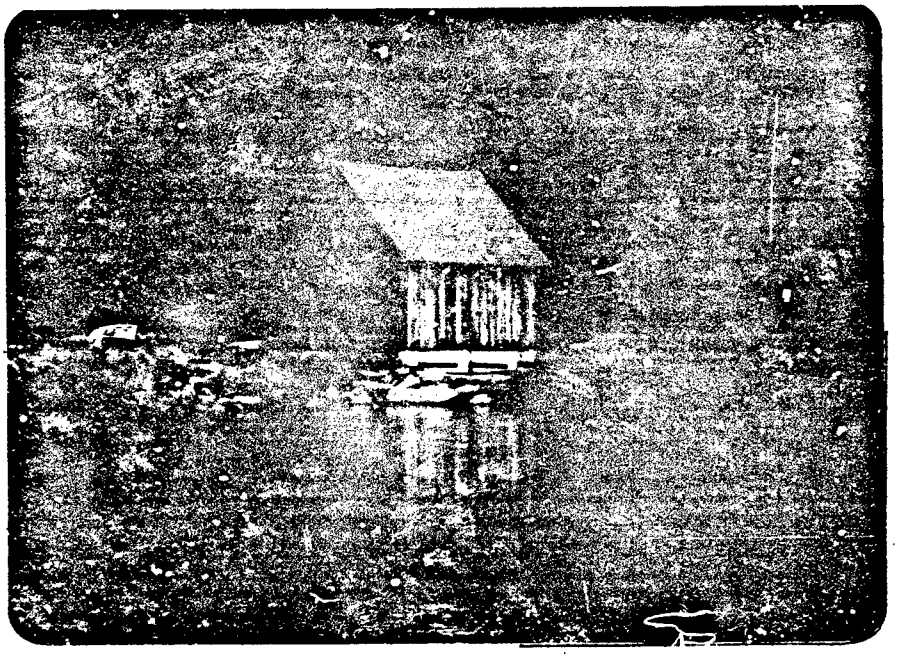


Overview of left side of dam from gatehouse



Overview of gatehouse near center of dam from upstream

- SCALE -

0 1/2 1 2 miles

FROM : USGS MONADNOCK QUADRANGLE MAP.

GOLDBERG, ZOINO, DUNNCLIFF & ASSOC, INC.
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LOCUS PLAN

NUBANUSIT LAKE DAM — NEW HAMPSHIRE

FILE No. 2067

SCALE AS NOTED

DATE JULY 1978

PHASE I INSPECTION REPORT

NUBANUSIT LAKE DAM, NH 00339

NHWRB 166.04

SECTION 1 - PROJECT INFORMATION

1.1 General

(a) Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Goldberg, Zoino, Dunnicliff & Associates, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed was issued to Goldberg, Zoino, Dunnicliff & Associates, Inc. under a letter of May 3, 1978 from Colonel Ralph T. Garver, Corps of Engineers. Contract No. DACW 33-78-C-0303 has been assigned by the Corps of Engineers for this work.

(b) Purpose

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

(2) Encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

(3) Update, verify and complete the National Inventory of Dams.

(c) Scope

The program provides for the inspection of non-Federal dams in the high hazard potential category based upon location of the dams and those dams in the significant hazard potential category believed to represent an immediate danger based on condition of the dams.

1.2 Description of Project

(a) Location

This dam lies in the Merrimack River Basin at the southwest end of Nubanusit Lake, approximately 2 miles north of the town of Harrisville. Access to the site is via Tolman Pond Road which intersects Nelson Road 0.3 miles south of the town of Nelson. The portion of the USGS Monadnock, N.H. quadrangle presented previously shows this locus. Figure 1 of Appendix B presents a detail of the site developed from the USGS map and the site inspection.

(b) Description of Dam and Appurtenances

The dam consists of a 279 foot long earth embankment with a maximum height of 8 feet and with riprap protection on some of the upstream slope (Appendix B, Figs. 2 and 3). The structure incorporates a gate section with an 11 foot long granite spillway and with two 4 ft. x 5 ft. gates (Appendix B, Fig. 4). Tolman Pond Road is directly downstream of the embankment. The owner can release water from Spoonwood Pond (Appendix B, Fig. 1) into Nubanusit Lake if necessary to maintain mandated levels in the larger lake.

(c) Size Classification

The dam's maximum impoundment of 7740 acre-feet places it in the INTERMEDIATE size category as defined by the "Recommended Guidelines."

(d) Hazard Potential Classification

The mill town of Harrisville, with a population of 300, is 2 miles downstream of the Nubanusit Lake Dam. While appreciable damage to buildings along Harrisville Pond and Nubanusit's downstream channel would result in the event of a failure, loss of life is not likely, given that the rise in Harrisville Pond would not be sudden since the valley is broad enough to spread the flood wave. Thus, the dam warrants hazard potential classification of SIGNIFICANT.

(e) Ownership

Mr. John J. Colony, Jr., c/o Harrisville Designs, Harrisville, N.H. 03450, owns the dam. His phone number is 603-827-3334.

(f) Operator

Mr. Colony, his brother, Mr. Charles Colony, and his son, Mr. John J. Colony III, operate the dam.

(g) Purpose

The primary purpose of the dam is to store water for recreational use, industrial processing and possible power generation in the Harrisville area.

(h) Design and Construction History

A 1936 NHWRB report indicates that initial construction took place in 1861; the first dam consisted of earth embankment with upstream rock protection, some of which is still visible. The report mentions one F. Upton as the architect/engineer for the project. The owner believes that a significant expansion of the dam, most likely to its present configuration, took place around 1896. No design drawings or construction plans are available.

(i) Normal Operational Procedures

On 1 June of each year, the NHWRB requires that the lake level be at gage elevation 12.5 (elevation 1375.23 MSL) and that gradual drawdown occur such that the level reaches elevation 11.1 by 15 September. The board also requires a minimum 2 cfs downstream flow. At other times, the owners operate the dam as necessary to satisfy industrial uses and to control flooding to the extent possible. The option of using water from contiguous Spoonwood Pond to maintain the mandated levels in Nubanusit is also available.

1.3 Pertinent Data

(a) Drainage Area

Nubanusit Lake receives runoff from a 6.1 square mile drainage area. The surrounding terrain is heavily forested and steeply sloping in most areas. There is limited year-round development along the lake, the majority of the 98 cottages and houses being summer residences.

(b) Discharge at Dam Site

Based upon a report prepared in 1977 by the NHWRB, the storm of record in this area was the 1938 hurricane, which approached the 100 year storm for the Nubanusit Lake vicinity. From a level 19 inches below full pond, the lake rose 37 inches or to a point 18 inches above full pond. Both 4 ft. x 5 ft. gates were completely open during this storm and flood.

(c) Elevation (ft. above MSL) (Gage El. 13.1 = 1375.8 MSL)

(1) Top Dam - 1379± (main crest); low point on crest 1377.2±

(2) Spillway Test Flood pool - 1380.1±

(3) Recreation pool - June 1 - 1375.2±
Sept. 5 - 1373.7±

(4) Spillway crest - 1374.7±

(5) Streambed at centerline of dam - 1362.7±

(d) Reservoir

(1) Length of maximum pool - 3.5 miles

(2) Storage - recreation 4600 acre feet
- top of dam 7640 acre feet

(3) Surface - 715 acres

(e) Dam

(1) Type - Earth embankment with riprap

(2) Length - 279 ft.

(3) Height - 16 ± feet

(4) Top Width - 10 feet ±

(5) Slide Slopes - Downstream 1:1; Upstream 1:15

(6) Zoning, Core, Cutoff - Unknown

(h) Spillway

(1) Type - Granite Slab

(2) Length of weir - 11 ft.

(3) Crest elevation - 1374.7 ft. ±

(4) Gates - 2 at 4 ft. by 5 ft each with 2 ft. x 3 ft. spiller at base.

(5) U/S Channel - 12 ft. wide with vertical stone side walls

(6) D/S Channel - Narrow with steep, rocky slopes

(i) Regulating Outlets

The 11-foot long granite spillway and the two flood gates permit regulation of the lake level as required by the NHWRB and commercial interests. Each 4 foot by 5 foot flood gate, which requires a chain hoist for operation, has a smaller 2 foot by 3 foot spiller gate built into its base. Threaded stems control the opening of the spiller gates. Water pressure holds the larger gates against their discharge openings and brass guides maintain the proper alignment during movement. The owner replaced the wooden portions of all gates with new cypress in 1959.

SECTION 2 - ENGINEERING DATA

2.1 Design

Neither Mr. Colony, whose family has owned the dam since its construction, nor the NHWRB have any original design drawings. The present structure is generally quite simple and incorporates no unusual design features. The design appears adequate for its intended purpose, having survived over 100 years and having successfully passed an estimated 100 year flood in 1938.

2.2 Construction

No construction records for the dam are available. Visual inspection of the embankments and outlet works revealed no major construction deficiencies. In general, the quality of the construction is as good as can be expected for a structure of this type built during this period.

2.3 Operation

The NHWRB has all records of dam operations from 1973 to the present and requires Mr. Colony to report all operations every two weeks. The owner also maintains records from 1965, when he first initiated formal record-keeping, to 1973.

2.4 Evaluation of Data

(a) Availability

As mentioned above, the original plans for this dam are not available, if indeed they still exist. Previous inspection and inventory reports, sketches, and correspondence concerning the dam, supplemented by the observations of the inspection team and interviews with the owner, form the basis of the information presented herein.

(b) Adequacy

The lack of indepth engineering data does not permit a definitive review. Therefore the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data; the evaluation is based primarily on visual inspection, past performance history and engineering judgment.

(c) Validity

The visual inspection, owners observations and hydrological analyses are of sufficient validity to warrant satisfactory evaluation.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

(a) General

The Nubanusit Lake Dam is in FAIR condition at the present time and requires no immediate remedial measures for continued safe operation under normal conditions. It does, however, require some maintenance work, the details of which Section 7 presents.

(b) Dam

(1) Embankment (Overview photos)

The two embankment sections which flank the gatehouse show no evidence of vertical or horizontal movement. There is no seepage with the junction of the outlet works and the ends of the embankments, where the fill tapers off to natural ground, are stable. The right embankment has a significant number of large trees growing along its entire length, while the left embankment has 3 trees growing near its far end.

Inspection of the embankment revealed two low volume seepage points on the right side of the dam. As indicated in Figure 2 there is a 0.05 gpm flow of slightly discolored seepage at the toe of the right embankment near the inlet to a 16 inch culvert under Tolman Pond Road. The area is in the drainage ditch for the road, but the primary flow issues directly from the embankment. The second flow, of about 0.1 gpm, is across Tolman Pond Road and about 10 feet from the outlet of the culvert mentioned above. Since the general area of this seepage is also in an area through which surface drainage would flow, positive identification of the flow as seepage through the dam is not possible.

Erosion has occurred all along the embankment. The riprap protection on the upstream face, some of which is part of the original rock crib and some dumped randomly as mass protection from ice run-up, does not fully cover the earth surfaces, resulting in localized areas of severe erosion.

(2) Spillway

The granite spillway, although submerged, was visible due to the clarity of water and appears to be in good condition (Figure 3).

(3) Gates

The operating mechanisms for the spiller gates are in good condition. The owner operated both gates with no difficulty.

Operation of the flood gates was impossible due to the lack of a chain fall or other hoisting mechanism. Additionally, the owner indicated that while he could open the flood gates at the present lake level (El. 11.85), they might not close properly due to the longitudinal force created at this particular head of water. He indicated that, from past experience, full closing of these gates was not possible until the water level dropped to elevation 6.5, almost 6 feet below that mandated at this time of the year.

(4) Outlet Culvert (Photo 1)

The abutments supporting the superstructure are in good condition with the exception of the wingwall extension of the left abutment. The outer end of this wingwall has unraveled due to undermining and has caused a full-length diagonal crack on the mortared portion of this wall. The right wingwall, which consists of dry rubble stone masonry, does not show any sign of distress or movement and is in good condition. The reinforced concrete slab supporting the roadway is in fair condition. There is some exposed longitudinal reinforcing steel at the downstream end of the slab and minor checking and efflourescence on the underside of the slab. The steel stringers spanning the remaining portion of the culvert are rusted, but do not show evidence of loss in cross-sectional area.

(5) Gate House (Photo 2)

The wood framed structure, its foundation supports and removable floor planking are in good condition.

(6) Trash Rack (Photo 3)

The trash rack upstream of the gate house waterway opening, although slightly rusted, is in good condition. The concrete wingwalls on either side of the trash rack are badly deteriorated with open joints and dislodged stones.

(c) Appurtenant Structures

The dam has no formal appurtenant structures. The nearby Spoonwood Pond Dam, however, discharges directly into Nubanusit Lake and, therefore, influences the hydrology of the lower lake (Fig. 1). Although Section 5 of this report briefly discusses the influence of the Spoonwood Dam on Nubanusit Lake, the condition of the structure is the subject of a separate report under this contract.

(d) Reservoir

An inspection of the reservoir shore revealed no evidence of movement or other instability. An examination of the surrounding watershed detected no work in progress or recently completed which might increase the flow of sediment into the lake or which might adversely affect the runoff characteristics of the basin.

(e) Downstream Channel

No observed downstream conditions exist which would adversely affect the operation of the dam or which pose a hazard to the safety of the dam. The hydrologic analysis of Section 5 does, however, consider the effects downstream of a major beaver dam and of an abandoned and breached rock crib dam.

3.2 Evaluation

The visual inspection of the dam, reinforced by historical information from the owner, permitted a satisfactory evaluation of those features which affect the safety and stability of this structure. The dam is in FAIR condition, as are appurtenant works.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

As noted previously, the NHWRB requires that the lake be at gage elevations 12.5 (USGS El. 1375.2) on 1 June and 11.1 (USGS El. 1373.8) on 15 September and that the intervening drawdown follow a more or less linear time-elevation relationship. The owner reports all dam operations to the NHWRB every two weeks. If the level in Nubanusit Lake falls below that specified, he releases water from Spoonwood Pond as required to raise Nubanusit. After 15 September, drawdown continues such that the lake is approximately 3 feet below full pond for the fall storm period. This practice conforms to the recommendations of the original builder of the gates, a Mr. Humphreys, who stated in an early publication provided by the owner that "it is much better and safer to have the pond three feet below high water mark in September, than it is to have it full with a rainfall that would cause it to rise three feet in a few days time." Some littoral property owners object to this procedure, desiring instead only 2 feet of drawdown. All drawdown is through the spiller gates, as the owner believes that the flood gates, last opened in 1938, would not properly reseat once opened. Mr. Colony maintains informal contact with the operators of the downstream McDowell dam to obtain advice concerning how much runoff will accompany a given storm or at which level he should set the lake in anticipation of spring snow melt. Only Mr. Colony, his brother Charles, and his son, John J. Colony III, operate the dam.

4.2 Maintenance of Dam

The dam receives frequent checks by the owner and regular inspections by the NHWRB. The owner implements those repairs induced by his own inspections or by the more formal NHWRB visits.

The most recent repairs, recommended by the NHWRB in 1976, involved the removal of trees from the embankment and the repair of concrete near the inlet to the gate house. While some work in these areas is evident, the removal of the trees is only partially complete. The delay is due to a boundary dispute with an abutter.

4.3 Maintenance of Operating Facilities

As mentioned previously, the owner replaced the wooded portions of the gates in 1959. With the exception of lubrication, the operating mechanisms require little or no other attention.

4.4 Description of Any Warning System in Effect

The dam's owner, who lives in Harrisville a short distance downstream, monitors the dam continuously during emergency periods. The tightly knit lake community assists him in this endeavor, rapidly notifying him of any problems with the structure.

4.5 Evaluation

The established operating procedures appear adequate for this dam. Some improvements are possible, however, particularly in the areas of increasing the capability for operating the dam in an emergency and of implementing recommended repairs.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

(a) Design Data

Data sources available from the New Hampshire Water Resources Board (NHWRB) included information collected for a review of the operating policy for the dam conducted by the NHWRB in 1977 and inspection reports from 1937, 1973, and 1974. The sources deal primarily with the physical characteristics of the dam and operating policy, which sets target elevations for the lake on June 1 and September 15 of each year. The data includes evaluation of the 100-year peak inflow and the historical peak inflow during the September 1938 Hurricane.

The available data do not contain a specific design flood, but do indicate the maximum outlet capacity is 695 cfs. From the available data it is unclear at what head and with what configuration of gate openings this was calculated.

A recent NHWRB review of the operating policy resulted in an order to the dam's operators to maintain elevations of 12.5 feet on the lake gage on June 1 of each year and gradually lower this to 11.1 feet on September 15. The crest of the spillway at 12.0 feet on the gage corresponds to elevation of 1374.7 feet MSL. A deed executed in 1870 established the legal full pond at gage elevation 13.1. Each fall, the owner drops the lake level to approximately 3 feet below "full pond" in anticipation of fall storms and spring runoff, where "full pond" is meant to the gage elevation of 13.1 or 1.1 feet above the spillway crest.

(b) Experience Data

There is no complete record of discharges from Nubanusit Lake. The dam owner maintains irregular records of the lake elevation between 1965 and 1973 and biweekly records since then; thus, approximations of the average daily flows between readings are possible from the dam rating curve after assuming positions for the adjustable gates. The peak flood occurred as part of the September 1938 hurricane when about 6.6 inches of runoff produced an estimated maximum inflow of 2915 cfs. During this storm, the lake rose from 19 inches below "full" to 18 inches above even though the flood gates were completely open. This rise corresponds to an estimated peak discharge rate of 860 cfs.

(c) Visual Observations

The dam owner operates the dam on a regular basis. Given the competing requirements of downstream users and lakeside property owners, maintenance of the lake level within narrow tolerances is imperative to satisfy all parties. A locked gatehouse contains the controls for the dam's outlet works. There is an 11 foot long spillway at elevation 12.0 feet on the lake gauge that acts as a sharp-crested weir under normal conditions. In addition, there are two sets of moveable gates. The emergency flood-gates each have a maximum opening of 4 feet by 5 feet and require a chain hoist for operation. Mounted on the face of these gates are smaller spiller gates used during the normal control of the lake. A threaded stem mechanism controls their operation and they have maximum openings of 2 feet by 3 feet each. The bottoms of all four gates correspond to elevation 0.0 feet on the lake gauge. The owner last operated the flood control gates in 1938 and doubts that he could properly reseat them once opened without significantly lowering the lake level. Thus, the owner is predisposed not to use the emergency gates until he is certain that overtopping of the dam is imminent. The main crest of the dam is 4.25 feet above the spillway crest. On the west side there is an access road to a boat launching area, opposite which there is a low point in the embankment some 1.75 feet below the average crest. Thus, the crest varies in elevation and this "low spot" would serve as the critical elevation for the start of overtopping.

(d) Overtopping Potential

The hydrologic conditions of interest in this Phase I investigation are those required to assess the adequacy of the dam in terms of its overtopping potential and its ability to safely allow an appropriately large flood to pass.

This analysis involves investigations to determine how the recommended Spillway Test Flood (STF) compares with dam discharge and storage capacities. None of the original hydraulic and hydrologic design records are available for use in this study.

The "Recommended Guidelines" specify Spillway Test Flood criteria based on the size and hazard potential classifications of the dam. Based on Corps' criteria for a dam classified as INTERMEDIATE in size and SIGNIFICANT in hazard potential, an appropriate STF is between 0.5 and 1.0 times the Probable Maximum Flood (PMF).

Calculation of an estimated PMF is possible by using the chart of "Maximum Probable Flood Peak Flow Rates" obtained from the Corps of Engineers, New England Division. The calculations consider the lake area to have "rolling" topography with a drainage area of 6.1 square miles. Use of the chart results in a flow rate of 1800 cfs per square mile. Given that Spoonwood Pond serves to reduce the runoff from 29 percent of the drainage area, a reduced runoff rate of 1500 cfs per square mile is reasonable. This reduction results in a PMF of 9150 cfs, one half of which is 4575 cfs.

The "Recommended Guidelines" suggest that where a range of STF is possible, the analysis should consider the magnitude that most closely relates to the involved risk. On this basis, since the risk is most likely on the higher side of the SIGNIFICANT category, an STF of 8000 cfs is appropriate as the inflow to Nubanusit Lake.

An important factor in determining the safety of the dam is the water surface elevation at the start of the storm runoff. The normal lake elevation is 0.5 feet above the spillway on June 1 and 1.0 feet below the spillway on September 15, with a gradual transition scheduled during those 3 1/2 months. During the remainder of the fall, the owner lowers the lake in anticipation of the spring runoff. During May the lake rises to full pond or higher,

with subsequent lowering to the required gauge elevation of 12.5 feet by 1 June. Faced with a predicted major storm, the operators of the lake would open at least the spiller gates to start lowering the pond. It is impossible to accurately predict at what elevation the lake might be at the start of the storm warning or how many hours would be available to lower the lake. Given these considerations, the analysis considered two possible starting water surface elevations. The first which was used for the primary Spillway Test Flood was a September 1 elevation of 11.5 feet on the lake gauge. The second case was the June 1 elevation of 12.5 feet on the gauge.

Applying the procedure suggested by the Corps of Engineers (New England Division) for "Estimating the Effect of Surcharge Storage on Maximum Probable Discharges" results in a final STF outflow of about 2370 cfs (390 csm) compared to an inflow of 8000 cfs (1310 csm). Thus, the lake has a significant dampening effect on the magnitude of the peak flow. The storage-stage curve for surcharge storage used to attenuate the STF assumed that the surcharge storage available was equal to the lake area (715 acres) times the depth of surcharge. Thus, no spreading or increases of area with depth occurs in the analysis.

The Stage-Discharge Curve represents the summation of flows occurring in each discharge sector. The following operational scenario forms the basis for the computation of this curve. Throughout this discussion, the head (H) is the distance above the spillway; in other words, H is equal to the lake gauge reading minus 12.0 feet.

(1) When H is less than 2.5 feet, all discharge is through the 2 completely opened spiller gates and over the spillway.

(2) When H is between 2.5 and 4.25 feet, the owner opens the flood gates fully and, simultaneously, water flows over the low point on the right embankment.

(3) When H is greater than 4.25 feet, water flows over the entire dam and the 268 feet of embankment act as a broad-crested weir. The overbanks at either end of the dam also act as broad-crested weirs, rising on soil slopes and with lengths varying as a function of H.

The peak test discharge of 2370 cfs results in a maximum stage of H = 5.4 feet with the flood gates open as described previously. The analysis also considered the cases of the June 1 initial water surface elevation and the possibility that the flood gates could not be opened. In all cases the main dam crest is overtopped with the depth of overtopping ranging from 1.15 to 1.75 feet.

5.2 Hydrologic/Hydraulic Evaluation

The results of the hydrologic and hydraulic assessment of Nubanusit Lake Dam indicate that the lake has a large storage capacity to attenuate flood inflows, but that for a storm of the magnitude of an STF, overtopping is likely even with the flood gates open.

The low point in the embankment at the boat launching area would be the first point of overtopping and, thus, could potentially represent the starting point of an overtopping failure. If the road were regraded to provide a uniform dam crest at 4.25 feet above the spillway, the dam could better withstand a storm of lesser magnitude than an STF.

Nubanusit Lake in conjunction with Spoonwood Pond represents a hydraulic system that contains a very large volume of potential surcharge storage relative to the total drainage area and, thus, runoff volume. For a case such as this, the shape of the runoff hydrograph would significantly affect the ability of the dam to withstand an STF magnitude storm. The methodology used to attenuate the inflow and, thus, determine the outflow of the lake was an appropriate approximation for the purposes of this study, but more detailed analysis including generation of a runoff hydrograph and a detailed routing through both reservoirs is necessary to thoroughly evaluate the conditions of the Nubanusit Lake/Spoonwood system.

An additional concern is the effect on Nubanusit Lake Dam of a potential failure of Spoonwood Pond Dam (NH 00338), the subject of a separate report in this series. Because of the different size and hazard potential classifications assigned each dam, the evaluation of Spoonwood Dam considers an STF significantly smaller than that used at Nubanusit. It is obvious, however, that any given storm would strike both drainage areas simultaneously and, therefore, Spoonwood Pond might receive runoff from a storm greater than that warranted by its own size and hazard potential classification based on the "Recommended Guidelines." Preliminary calculations within the scope of the Phase I investigation indicate that the failure of the Spoonwood Dam is unlikely to induce the failure of the Nubanusit Dam, but a more complex and detailed analysis is necessary to verify this conclusion.

5.3 Downstream Dam Failure Hazard Estimates

Use of the procedure set forth in "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs," Corps of Engineers, New England Division, April 1978, permits estimation of the downstream flood hazards that would result from a failure of the dam. This procedure allows for the attenuation of dam failure hydrographs in computing flows and flooding depths in downstream areas. The calculations take into account the approximate hydraulic and storage characteristics of the stream reaches.

This analysis considers four reaches downstream of the Nubanusit Lake Dam. The first reach is the outlet of Nubanusit Lake for the first 1200 feet downstream to the junction with Brickyard Brook. The second reach is from that junction downstream 1 mile to a beaver dam at the site of a former old mill dam. The third reach runs 2400 feet to the inlet of Harrisville Pond. The fourth reach consists of Harrisville Pond.

The basic assumption used in computing the peak flow from a dam failure is that failure occurs with overtopping of the embankment, or when H = 4.25 feet. This stage represents a total depth above the stream bed of 16.25 feet. Of the total dam length of 279 feet, the analysis assumed that a breach width of 100 feet would occur under failure conditions. These assumptions result in a peak outflow from the dam of 11,000 cfs.

Reach 1 offers very little storage capacity and thus the flood peak would pass with very little attenuation and flood depths on the order of 9 feet. In Reach 2 the valley flattens and widens considerably. Here there is adequate storage to reduce the peak flow by nearly 1000 cfs to 10,000 cfs, with resulting flow depths of up to 13.5 feet. Reach 3 consists of a steep, narrow channel that offers little storage or attenuation, so that the flow throughout this reach would be about 10,000 cfs with a depth of about 12 feet. In Reaches 1 and 2, there is no development subject to damage by these depths of flooding. Several homes in the area known as Mill Village, just below the beaver dam in the upper portion of Reach 3, are subject to damage by a few feet of flooding. These homes are high enough, however, that the loss of life hazard is minimal.

Reach 4, which includes the Harrisville Pond area, is a reach having a significant hazard potential. Many homes located along the lake front, particularly those in Harrisville Village at the pond outlet, lie within the area of influence of a dam failure at Nubanusit. The capacity of the outlet works at Harrisville Mill is minimal and the pond would probably overtop its banks by several feet in the village area and at the east outlet (about 500 feet east of the mill dam). Flood waters would flow along the roadways in the village and around the mill buildings to rejoin Nubanusit Brook below the village. Although significant damage in this region is likely, the loss of life potential probably is not great. The Harrisville Pond Dam is the subject of a separate dam inspection report, which should cover the potential damage to this area in more detail.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

(a) Visual Observations

The extensive field investigation of the dam indicated no significant displacements and/or distress which would warrant the preparation of structural stability calculations based on assumed section properties and engineering factors.

(b) Design and Construction Data

As mentioned previously, a check of records held by the present owner and by the NHWRB yielded no plans or calculations of value to a stability assessment.

(c) Operating Records

As mentioned previously, the dam owner has maintained the operating records since 1965. The NHWRB has copies of those since 1973. These records reveal no evidence of instability during the period covered. While no records are available for the 1938 hurricane, the dam did survive the accompanying 100 year flood without notable damage.

(d) Post Construction Changes

The results of the field investigation and a check of available records produced no evidence of changes to the dam or surrounding area that would influence stability of the structure.

(e) Seismic Stability

The dam is located in Seismic Zone No. 2 and in accordance with recommended Phase I guidelines does not warrant seismic analyses.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

(a) Condition

The condition of the Nubanusit Lake Dam is FAIR at the present time.

(b) Urgency

The improvements recommended herein require implementation by the owner within 1 to 2 years after receipt of the Phase I Inspection Report.

(c) Need for Additional Investigation

A thorough analysis of the Nubanusit/Spoonwood system requires the development of the complex hydrologic interaction for this two dam system.

7.2 Recommendations

The existing spillway capacity is inadequate to pass the STF without overtopping. An engineering study to examine potential solutions to this problem such as the feasibility of maintaining lower lake levels, expanding the existing discharge capacity, raising the height of the embankments, or some combination of the above would help to facilitate correction of this shortcoming.

The installation of a communications system between the Nubanusit gatehouse and the town of Harrisville would significantly enhance the owner's ability to warn downstream residents in the event of an impending failure.

The owner should establish a formal system with local officials for warning downstream residents in case of emergency. Round the clock surveillance should be provided by the owner during periods of unusually heavy precipitation.

7.3 Remedial Measures

Depending on the results of the recommended investigations and since the maintenance of lower lake levels would not satisfy either commercial or recreational users, the dam will most likely require either an increase in discharge capacity or an increase in the height of the embankments by at least 1.75 feet. The latter course of action probably represents less of a monetary expenditure and fits in well with some of the O & M procedures discussed below.

(a) O & M Procedures

(1) Install new gate guides or improve the existing ones to permit easy and accurate opening and closing of both flood gates under anticipated storm conditions.

(2) Institute a monthly program for monitoring the 2 seepages mentioned previously, with particular attention devoted to the quantity and turbidity of the flow.

(3) Repair the deterioration to the upstream wingwalls by resetting all stones and mortaring all joints.

(4) Remove all trees and brush from the embankments. Consultations should first be held with forestry experts on the implications to the dam of removing mature trees over 3 inches in diameter.

(5) Repair all eroded areas on both embankments, to include raising the low area previously mentioned. Place additional riprap to insure adequate protection for all earth areas.

(6) Clean all debris from the immediate downstream channel.

(7) Insure the gate is properly set by verifying that gage elevation 13.1 is at USGS elevation 1375.83.

(8) Store the chain hoists for the flood gates in the gatehouse as opposed to at the Harrisville Mill.

(9) Reset all unraveled stone on the left downstream wingwall and clean and paint the steel members supporting the concrete road slab.

(10) To establish a reliable back-up force available in emergencies, instruct local public safety officials in the operation of the dam and provide those so designated with keys and necessary tools.

(11) Institute procedures for periodic inspection of the dam and appurtenant works on an annual basis in supplement to the more frequent inspections recommended for the suspect seepage zones.

APPENDIX A

VISUAL INSPECTION CHECKLIST

INSPECTION TEAM ORGANIZATION

Dates: 14 June, 1974 - 2:30 p.m.
19 Julv, 1978 - 11:00 a.m. (Operating mechanisms)

Project: NH 00339
NUBANUSIT LAKE DAM
Nelson, New Hampshire
Nubanusit Brook
NHWRB 166.04

Weather: Sunny, warm both days

Inspection Team

James H. Reynolds	Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZDA)	Team Captain
William S. Zoino	GZDA	Soils
Nicholas A. Campagna	GZDA	Soils
Robert Minutoli	GZDA	Soils
Andrew Christo	Andrew Christo Engineers (ACE)	Structural & Mechanical
Paul Razgha	ACE	Structural & Mechanical
Richard L. Laramie	Resource Analysis, Inc.	Hydrology

The dam owner, Mr. John J. Colony, accompanied the inspection team on the July 19, 1978 visit and Dr. Norris Robertson provided boat transportation.

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
EMBANKMENT		
Vertical movement and alignment	NAC	None
Horizontal movement and alignment		None
Surface cracks		None
Conditions at abutments and at juncture with spillway and gate section		No deficiencies noted
Trespassing on slopes		Not significant
Sloughing or erosion of slopes and abutments		Considerable erosion on upstream slope - downstream slope heavily vegetated
Trees or animal burrows on slopes		Numerous trees requiring removal on right side, 3 at end of left side
Riprap slope protection		Some loose rock dumped at toe of slope, but riprap is generally inadequate to protect the embankment
Unusual movement or cracking at or near toe		None
Unusual embankment or downstream seepage	NAC	Seepage at .05 gpm noted near inlet to road culvert on right side, and 0.1 gpm 10 ft. culvert outlet; the water near the culvert inlet is slightly discolored, while near the outlet is clear.

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Piping or boils	MAC	None noted
Foundation drainage features	AM	None detected or shown on available documents
OUTLET WORKS		
(a) Approach channel		
Bottom conditions	AM	Sandy bottom free of debris or obstructions
Log boom	AM	None required
Fish and trash racks	HC	Rack of 1-1/2" x 3/8" flat bars on 1" centers is rusted but in good condition
Loose stones	AC	Stones displaced horizontally and vertically
Erosion of joints	AC	Most joints completely open
Erosion under base of wall	AC	Considerable erosion all around walls
(b) Gates		
Condition	AC	Wood replaced in 1959
Serviceability of threaded stems for small gates	AC	Operating condition good
Serviceability of chain hoist for large gates	HC	Hoist stored in Harrisville; flood gates not operated
Gate mountings	AC	Owner does not believe flood gates can be reseated if opened; gates held by water pressure and slide in brass guides

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Adequately secured (tamperproof)	AC	Locked gatehouse
(c) Spillway		
Condition of granite slab	AC	Good
Mounting of slab	AC	No deficiencies noted
(d) Outlet Channel (immediate area)		
Slope conditions	MAC	1:1 rocky slopes on both sides
Rock slides or falls		None noted
Control of debris		Many small branches and logs in channel
Trees overhanging channel		Channel heavily wooded on both sides with many trees over channel
Other obstructions		Beaver dam and breached rock crib dam 1 mile downstream
Erosion at outlet	MAC	None
Condition of road and bridge	HC	Rust on supporting steel; minor efflourescence and checking on roof slab; some exposed reinforcing
Condition of stone masonry walls supporting bridge	AC	
Loose stones	AC	Some unravelling on left side; joints only partly mortared
Erosion of joints	AC	
Erosion under base of wall	AC	Some erosion on left side
(e) Existence of gages	MAC	Gage inside gatehouse. Gage apparently reset in 1976, but at wrong elevation. 1975 NHWRB indicates spillway at 12.0 on gage, but now at ≈11.55

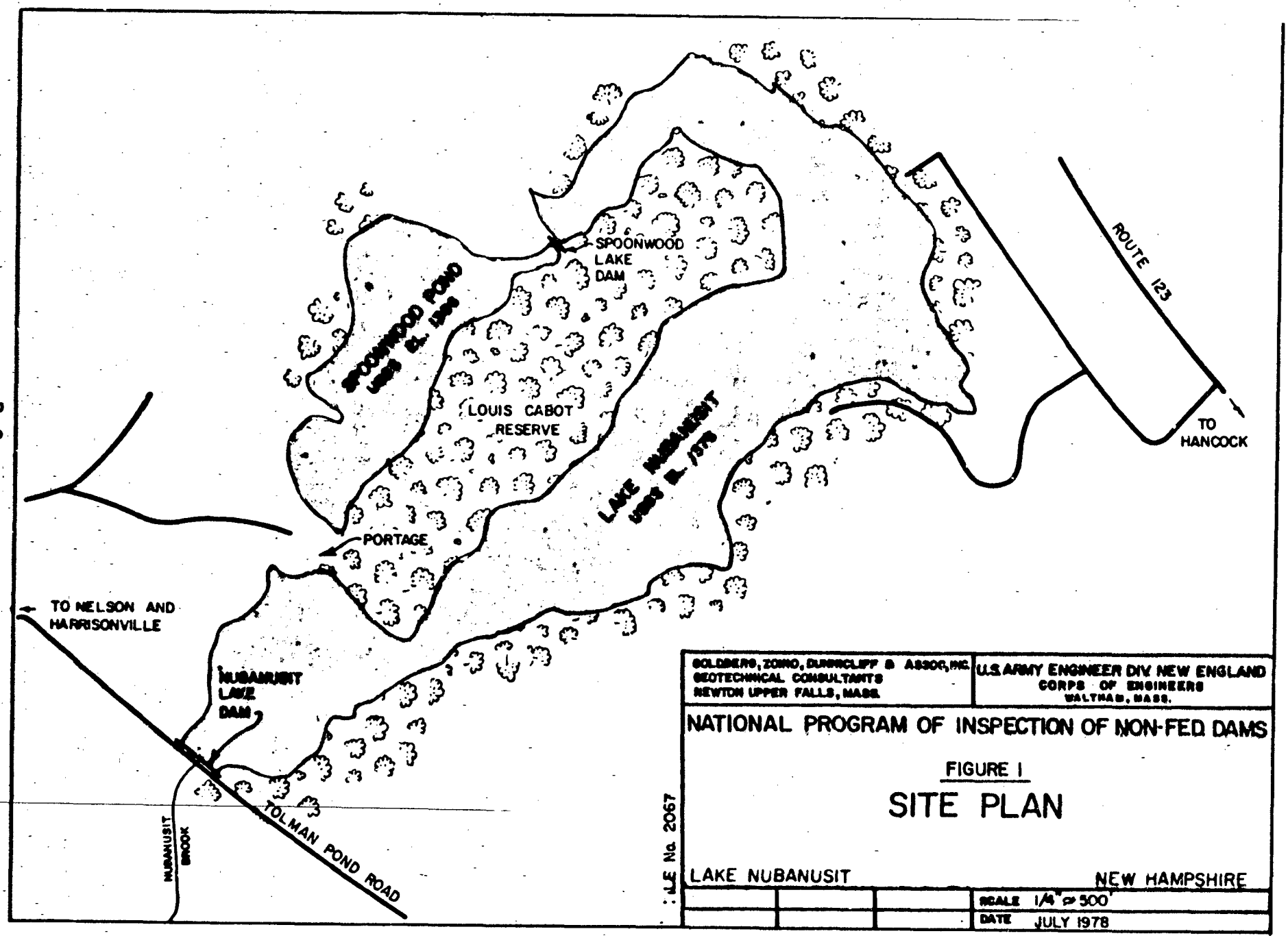
CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
RESERVOIR		
(a) Shoreline		
Evidence of slides	NAC	None noted
Potential for slides		Entire shoreline appears stable
(b) Sedimentation		None noted
(c) Upstream hazard areas in the event of backflooding		98 cottages located around lake's shore, of which 50% subject to inundation if lake rises 7 feet
(d) Changes in nature of watershed (agriculture, logging, construction, etc)		No change noted-watershed primarily heavy forest
DOWNSTREAM CHANEL		
Restraints on dam operation		Large beaver dam and breached rock crib dam about 1 mile downstream
Potential flooded areas		Only 2 homes between dam and Harrisville pond, but heavy development around pond and near Harrisville dam.
OPERATION & MAINTENANCE FEATURES		
(a) Reservoir regulation plan		
Normal procedures		Lake at 12.5 gage on 1 June and 11.1 gage on 15 September
Emergency Procedures	NAC	Owner operates dam as necessary during other periods to control flooding and to permit commercial use of water downstream

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Compliance with designated plan	JAC	Present year is first under plan and is being closely monitored by NHWRB
(b) Maintenance		
Quality		Tree removal recommended by NHWRB for 1977 not accomplished, partly due to boundary dispute
Adequacy	JAC	Maintenance of operating facilities adequate

APPENDIX B



SOLDBERG, ZOINO, DUNNCLIFF & ASSOC, INC.
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

FIGURE 1

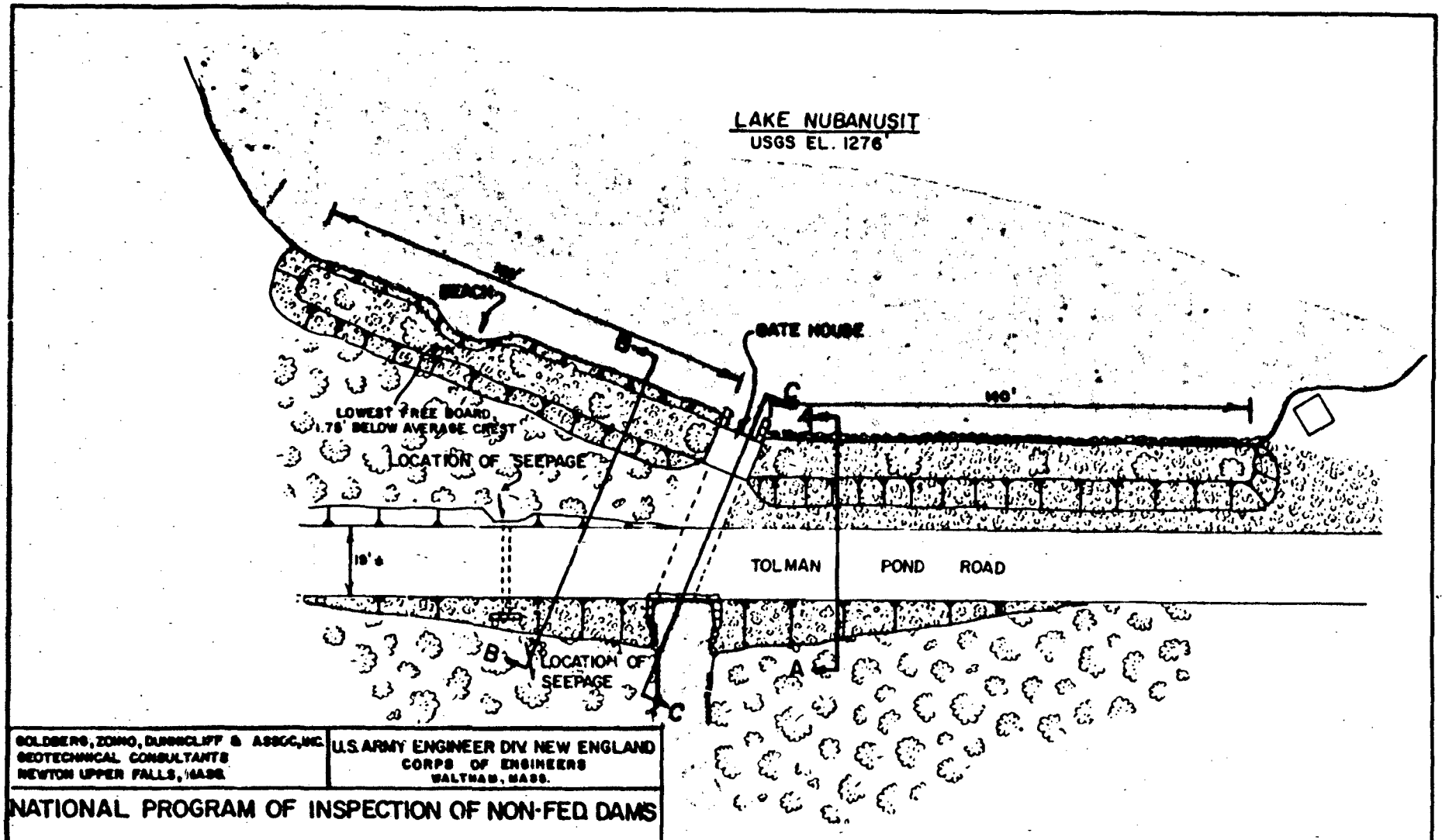
SITE PLAN

LAKE NUBANUSIT — NEW HAMPSHIRE

SCALE 1/4" = 500'

DATE JULY 1978

LE No. 2067



GOLDBERG, ZOINO, DUNNCLIFF & ASSOC, INC.
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NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

FIGURE 2

PLAN OF DAM

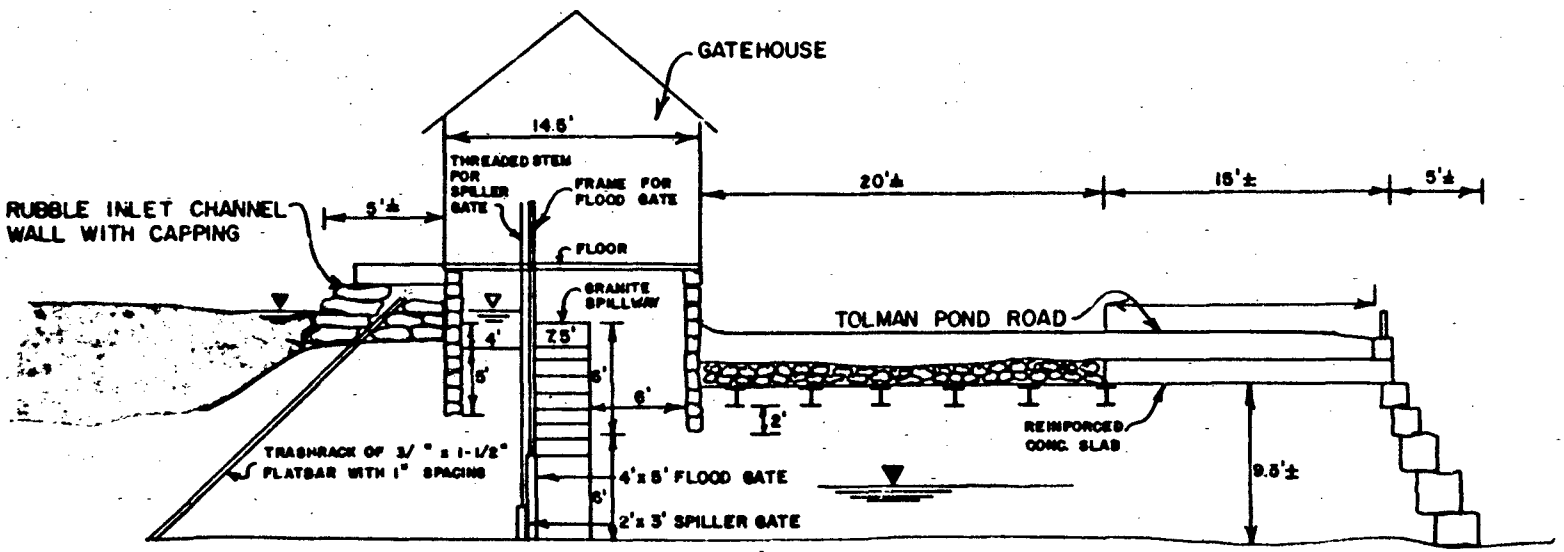
LAKE NUBANUSIT — NEW HAMPSHIRE

SCALE 1" = 40'

DATE JULY 1978

B-3

FILE No. 2067



SECTION C-C'

SCALE: 1" = 10'

NOTE: WATER LEVELS MEASURED 18 JULY 78. WATER FLOWING 4" OVER SPILLWAY DURING INSPECTION.

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NEWTON UPPER FALLS, MASS.

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CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

FIGURE 3

SECTION OF DAM

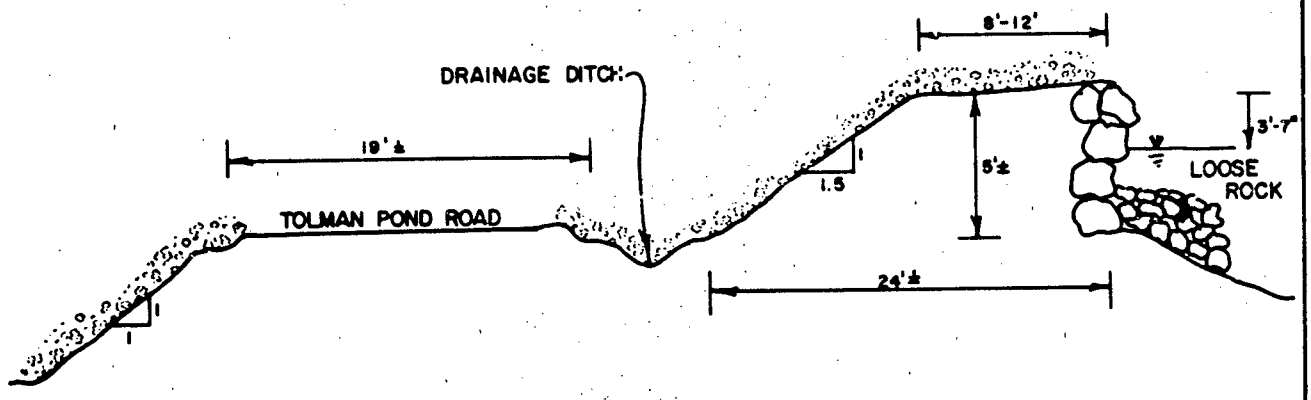
LAKE NUBANUSIT — NEW HAMPSHIRE

SCALE AS NOTED

DATE JULY 1978

FILE No. 2067

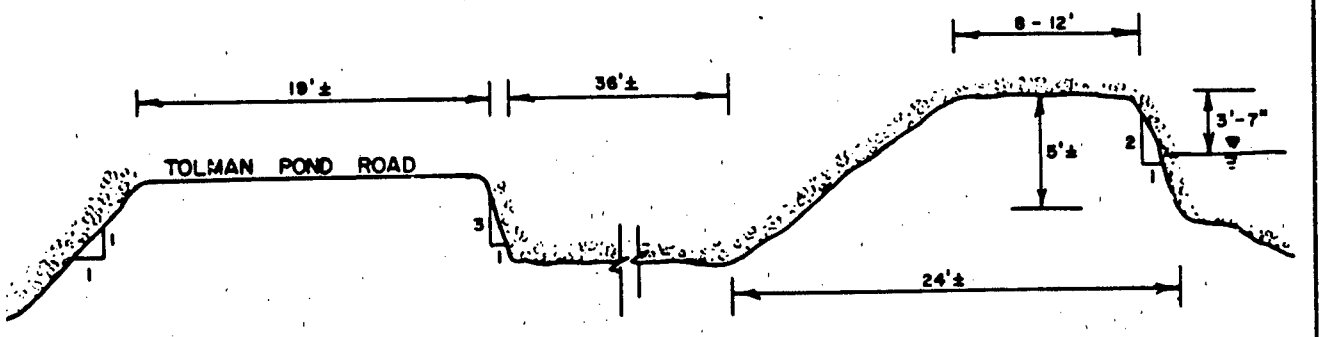
B-4



NOTE: WATER LEVEL MEASURED 14 JUNE 78.

SECTION A-A'

SCALE: 1"=10'



NOTE: WATER LEVEL MEASURED 14 JUNE 78.

SECTION B-B'

SCALE: 1"=10'

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CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

FIGURE 4

SECTION OF DAM

FILE No. 2067

NUBANUSIT LAKE DAM NEW HAMPSHIRE

SCALE AS NOTED

DATE JULY 1978

The NHWRB maintains a copy of most documents regarding the Nubanusit Lake Dam. Included in these records are:

a) Letter from Filtrine Manufacturing Company to the NHWRB dated 24 August 1977 concerning the uses of Nubanusit's discharge in Harrisville.

b) Letter from the dam owner to the NHWRB dated 20 August 1977 outlining the owner's position on the July 1977 public hearings.

c) Design data for a hydroelectric installation for Filtrine's plant in Harrisville prepared by Niagara Waterwheels Ltd. and dated July 1976, which discusses the hydrology of Nubanusit Lake and Spoonwood Pond.

d) Letter from the NHWRB to the owner dated 7 January 1976 outlining repairs recommended by the board based on a 12 December 1975 inspection.

e) NHWRB inspection report dated 12 December 1975 (not included in report as it contains no useful information).

f) Analysis of Nubanusit discharges between January 1973 and August 1974 by the NHWRB.

g) Dam operating data from January 1973 to August 1974.

h) NHWRB inspection report dated 7 November 1974 (not included in report as it contains no useful information).

i) A 1939 report by the New Hampshire Water Control Commission entitled "Data on Dams in New Hampshire."

j) A 1939 report by the same agency entitled "Data on Reservoirs and Ponds in New Hampshire."

k) A 1937 NHWRB report entitled "Inventory of Dams and Water Power Development."

Additionally, the New England Division of the Corps of Engineers has published a report dated April 1974 which covers flood plains in the town of Peterborough, N. H., an area which includes this dam.

State of New Hampshire

WATER RESOURCES BOARD

CONCORD 03301
37 Pleasant Street

September 27, 1977

136.34

Messrs. Charles Colony & John J. Colony, Jr.
c/o Harrisville Designs
Harrisville, New Hampshire 03450

Gentlemen:

At a meeting of the New Hampshire Water Resources Board held at Pittsburg, New Hampshire on September 17, 1977, having reviewed all the data presented at the public hearing and in the files of the Board along with staff recommendations, the following findings as required by the provisions of Chapter 484, "Lake Levels Investigation and Proceedings" have been adopted:

1. That Nubanusit Lake is a public water of the State.

2. That the operation, control and management of the dam at the outlet of Nubanusit Lake by John, Jr. and Charles Colony is a lawful use.

3. That, as a result of this investigation, the Board is of the opinion that a change in the manner of exercise of right of management and control of this public water would be of benefit to the owners of the shore property and the public .

4. That such change and management and control for the benefit of others would not cause undue injury to the owners of the outlet.

It is, therefore, directed that the owners of the dam at the outlet of Nubanusit Lake, John, Jr. and Charles Colony shall operate the level of Nubanusit Lake for the benefit of the recreational use of said public waters in such a manner that the level of the lake shall be maintained at or about an elevation of 12.5 feet on the gauge on or near June 1 each year and at or about an elevation of 11.0 feet by September 15 of each year.

That the discharges from said dam shall be controlled such that between June 1 and September 15 of each year the level of the lake shall be lowered in a gradually decreasing fashion starting at 12.5 feet on June 1 and arriving at 11.0 feet on September 15 as shown graphically on the attached chart, to the extent that weather conditions permit, provided however that if the aforesaid level is not maintained the burden will be upon the owner to show that said variations resulted from causes beyond his control.

Messrs. Charles Colony & John J. Colony, Jr.
Page Two
September 27, 1977

That the minimum flow downstream of Nubanusit Lake not be reduced below 2 cubic feet per second at any time.

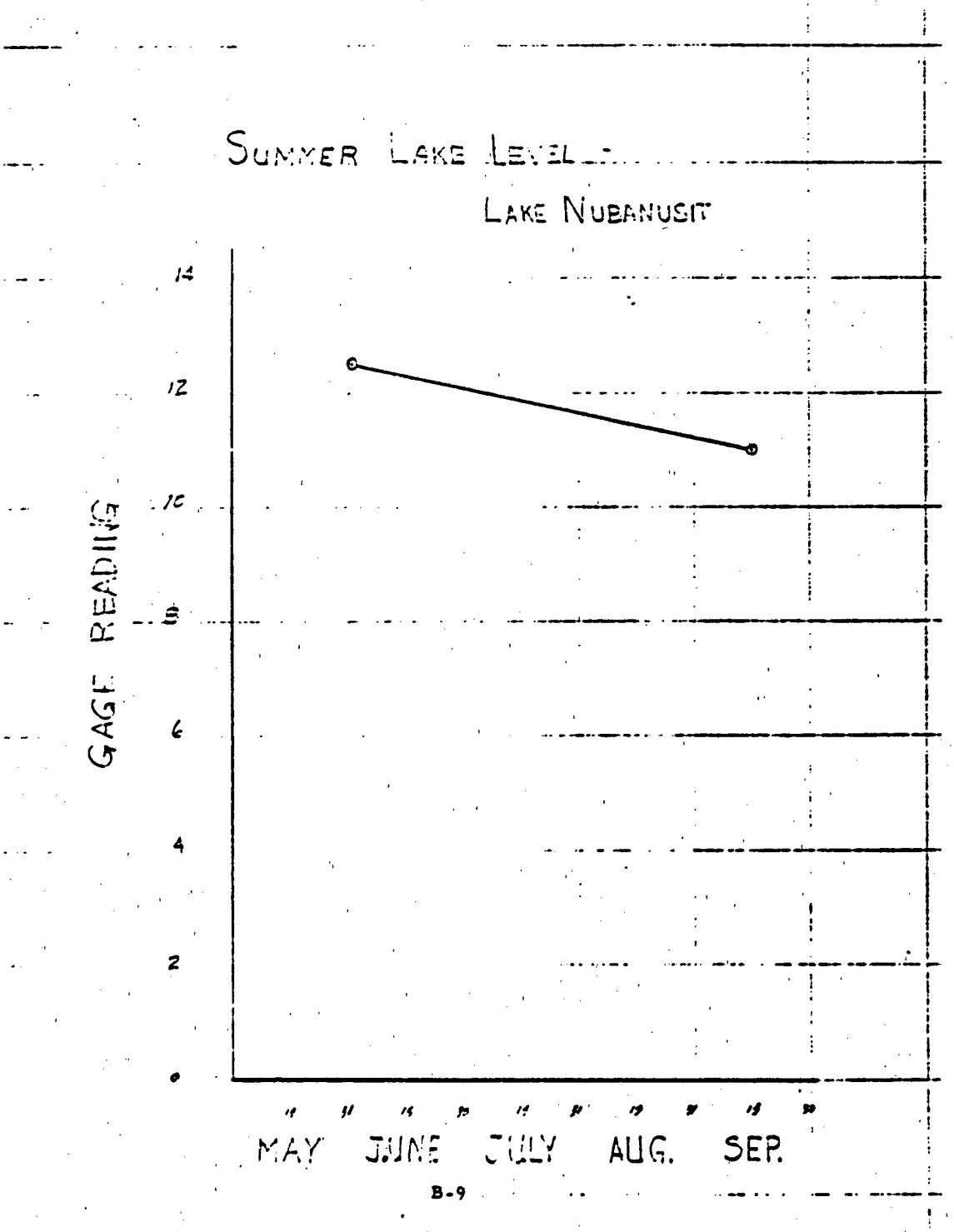
If you have any questions regarding the above, please contact us.

Sincerely,

George McGee

George M. McGee, Sr.
Chairman

GMM/VAK:L
Attachment


SUMMER LAKE LEVEL
LAKE NUBANUSIT
GAGE READING
14
12
10
8
6
4
2
0
MAY
JUNE
JULY
AUG.
SEP.

NUBANUSIT LAKE STUDY

SUMMARY

STATEMENT OF OPINIONS

1) Record files in the office indicate that only minimal commercial uses exist downstream of Nubanusit, though actual hydroelectric generation will exist after certain agreements can be made between Filtrine and the Colonys. Therefore the only current bona-fide use of Nubanusit waters is for recreation.

2) Investigation indicates that the above current management and control is lawful and shall be directed as follows with a 1/2 foot accepted alowable tolerance (weather permitting).

Lake level on gage (Full pond = 13.1)
June 1st September 15th
12.1 - 1 foot drop thru summer - 11.1

This recreational season guideline can be accomplished by closing the gates to store the spring rains and snowmelt and to have a "full pond" around the 1st of May. Then opening the "Spiller gates" as appropriate to draw off the top 1+ foot by the 1st of June. The gates may then be closed again (leakage allows sufficient generous baseflow of 0.2 cfs/mi^2) as required to achieve above level. After the 15th of September the gates may be operated for the storage of normally expected winter snows and spring rains. This is not to take precedence over prudent operations during storm events which may require additional dam and gate operations.

3) Because this lake does not currently produce any income, and the proposed operation is not a significant change from previous operations, no financial damage is recognized.

SUGGESTED FUTURE CONSIDERATION

1) As previously indicated the reservoir system of Spoonwood Pond, Lake Nubanusit, and Harrisville Pond can be managed to provide sufficient water for a variety of uses year-round within an acceptable tolerance. This should be reconsidered as a viable operation after a formal long term agreement between Filtrine Manufacturing and the Colonys is adopted for the use of water to run their turbine.

   A) Suggested operation: Close Spoonwood's gate in the fall probably after the 15th of September. Due to the release of its stored water during the summer, it should be down substantially and ready to store the anticipated precipitation of the winter and spring.

   B) Adjust the flow discharge from Nubanusit to satisfy the usual fall drawdown schedule which has shown to be effective in the past. This discharge should be tempered to some degree to insure a constant supply for Filtrine.

   C) After the drawdown of Nubanusit is accomplished a steady discharge of 15 cfs daily from Nubanusit would supply the Torbine's needs for an eight hour shift.

D) Maintain this flow during the spring snowmelt to insure adequate flow and the filling of the lake.

E) As weather conditions permit and the lake level approaches "full pond" on the 1st of May, adjust the gates and/or splash boards as appropriate.

F) Adjust the flow discharge to a minimum of 10 cfs on the 1st of May to be down approximately 1 foot on the 1st of June.

G) As conditions dictate open gate at Spoonwood to a flow of 5 cfs. This would probably occur near the end of July or early August.

COMMENTS

]) The suggested future operation is advantageous over strictly recreational use only for the following reasons.

A) Multiple use of the resource is obtainable if properly managed.

B) Can be income producing or at least cost effective, ie. whatever costs are incurred would be paid for by downstream user.

C) Incurrs a minimal operation of Spoonwood Dam.

D) Satisfied operational request made by majority of Nubanusit abutters.

E) Satisfies request of Lake Skatutakee abutters for adequate "flush-flow" thru "their" lake.

F) More than amply satisfies fish-flow requests by Trout Unlimited and the Fish and Game Department.

G) With normal weather conditions prevailing there would be a more stable and managed withdrawal from Spoonwood and Nubanusit than previously; hence, a more satisfied public.

LAKE NUBANUSIT STUDY

AN OUTLINE SUMMARY

1) Dam owners: John J. & Charles Colony (Nubanusit Lake Dam)
2) "Water rights": All artifically stored water may be reasonably used. Dam owners have deeded rights to draw 11'-10" from "full pond" as indicated by two pipes (painted red) in a boulder in the lake. The gage reading being 13.10 at "full pond".

3) Present Operation: Lake Nubanusit is a storage reservoir for downstream uses. Owners may operate dam to maintain flow in brook for any reasonable downstream use and lake level may fluctutate anywhere within the 11'-10" allowable drawdown.

4) Stream Baseflow: Fish & Game Dept. request is 0.2 cfs/mi^2 discharge at the dam. Drainage area is 6.1 mi^2. Baseflow would be 1.22 cfs through dam. In other words a trickle. Gate could be totally closed and leakage would supply flow in excess of one cfs.

5) Drainage area: 6.1 mi^2.

6) Flood flows: Q_{15} = 290 cfs; Q_{100} = 650 cfs.

7) Lake Surface (at full pond): Area: 715 Acres; Altitude: 1376' MSL

8) Max. flow capacity: 695 cfs (w/o backwater form bridge channel sluiceway). (thru dam structure)

9) Original Mill Uses: I) To provide a reasonably constant downstream flow thru Harrisville Pond & Lake Skatutakee.

II) To provide sufficient flow into Harrisville Pond to maintain a full pond.

10) Current uses for Nubanusit:

I) To provide flow into Harrisville Pond which supplies:
   a) The energy resource to generate electrical power at Filtrine Manufacturing Co. Via an informal agreement.

   b) A constant water supply for: 1) fire protection equipment at Filtrine Mf. and local community area via pumps at mill. 2) fresh water supply for mill and local area. 3) Process water for Filtrine Mfn.

II) Recreation - Boating & Fishing

11) Requests made by Lake Nubanusit Assoc. Inc. and others:

A) Maintain lake level adequate for recreational purposes ie., 12.0 on gage on June 1st & 11.0 gage on Sept. 15th (straw vote taken at public hearing) w/tolerance of ± 0.5'.

B) Lake level and streamflow properly managed for fishing interests.

C) Maintain sufficient flow to keep Harrisville Pond full for aesthetic reasons, hydroelectric power generation and other uses at Filtrine Manufacturing and the local surrounding area.

D) Maintain sufficient flow to keep Skatutakee full and adequately flushed to prevent an "Algae Bloom".

E) WRB to review the dam owners operation and recommend an operational procedure.

F) WRB to review and comment on projected damages due to any recommended change of dam operation.

G) WRB to review any possibility of accepting liability and damages as caused by the directed change in dam operation.

12) Flood Potential

1) Storm of record: Hurricane and flood of 1938

A) Dam operation: Lake down 19 inches from full prior to storm
Lake rose to 18 inches above full during peak flooding
Gates were opened during storm to save structure from possible failure

B) Summary of storm (w/accomp. rains) indicates it approached the 100 year frequency for the Nubanusit vicinity.

2) Dam structure can handle estimated peak flow of the 100 year frequency.

3) Downstream conditions limit peak flows (if non-destructive) to the 50 year frequency at two locations.
A) Exiting Harrisville Pond (at town bridge near library
B) Dam at Skatutakee Lake

4) Data indicates that in order to store the estimated runoff from a 100 year frequency storm, w/o operation, and within the deeded operating limits, the lake needs to be down 3-3 1/2' from full.

5) If the deeded "full pond" limit is removed from consideration, and the dam is considered structurally sound, then the lake level needs to be down 0.5' to 1.0 feet from "full pond" to handle the 100 year storm flows w/o operation.

13) Available operational options (for "normal" weather conditions prevailing)

A) Operate dam at Nubanusit for strickly recreational purposes as requested by lake abutters with discharge limited to fish flow requirements only. (A generous 0.2 cfs/ mi^2 flow would be 1.22 cfs discharge for the watershed. This outflow can be met easily even w/gates closed, ie. leakage).

B) Operate dam at Nubanusit as a storage reservoir for the purpose of maintaining a "full pond" at Harrisville and Skatutakee, and provide an adequate "flow through" to prevent algae blooms. (This years operation appears to satisfy this request: discharge approximate 8 cfs).

C) Operate dams at Harrisville Pond and Nubanusit to provide sufficient flow into Harrisville daily and to generate electrical power at Filtrine Manufacturing Co. for an 8 hour shift. (This flow needs to be 15 cfs entering Harrisville, of which 10 cfs would be coming from Nubanusit daily).

D) Operate dams at Spoonwood, Nubanusit and Harrisville to provide adequate flow for hydropower, electric generation and recreational use of Harrisville and Nubanusit if variable pond elevations will be tolerated on all three ponds.

14) Discussion

A) Option "A". This is not a viable request because the dam owners who do have a large investment in the construction and maintenance of the dam and the rights to draw water from the storage reservoir are not being paid any consideration. Perhaps some mutually agreeable financial arrangement between the dam owners and lake abutters could be devised to make this option acceptable to all parties concerned.

B) Option "B" This option is equally unworkable for the same reason as "A" - no compensation is being allowed, and the dam owners are carrying the entire financial burden. Besides that, the W.S.P.C.C. does not allow streamflow dilution as an acceptable alternative to construction of adequate sewage disposal systems.

C) Option "C" Of those provided this is the first option which meaningfully satisfies several requests. It requires, however, a nearly full pond at the start of summer and a tolerable drop of lake level of approximately 2.5 feet. It adequately draws the lake down for storage of the anticipated fall rains, provides abundant "fish flow" in Nubanusit Brook and thru Lake Skatutakee. This option should also supply sufficient water to operate Filtrine's turbine if Harrisville Pond is carefully managed. In other words Lake Nubanusit is once again being utilized for its original intent - a reservoir.

D) Option "D" The additional careful management of Spoonwood should allow for sufficient storage release in late summer if Nubanusit drops too low or too fast. This option has the additional benefit to those of "C" as Nubanusit can also be used for recreational (boating) purposes. Since there are no buildings on the shores of Spoonwood large fluctuations in water level (if necessary) can be tolerated.

15) Conclusions

A) The issue of taxes should not even be considered by the Board as it is a conflict between the towns and landowners.

B) Since Nubanusit is partially artificial and the dam is quite conspicuous, prospective cottage owners should investigate the history of the lake prior to any sale or construction of any structure. Their claim of not having lake-front property is true, however, they currently still have unrestricted access and use of the lake.

C) The dam which impounds Lake Nubanusit has sufficient capacity to pass storms with frequencies up to the 100 year providing that the gate and bridge channel sections remain clear of obstructions. During this event it would require that the "flood hazard" gates be opened and splash boards be removed from the spillway crest. The 1938 hurricane is the storm of record and the dam safely passed those flows as operated.

D) To operate Nubanusit Dam solely for recreation on that lake is not a realistic operation when you consider that there are both energy and income producing uses downstream.

E) The reservoir system that includes Harrisville Pond, Lake Nubanusit and Spoonwood Pond can adequately supply water for the various uses to which it is put during a year of normal precipitation if properly managed within acceptable operating limits.

F) Since this report does not recommend any drastic alteration from the owners past operation except to suggest that more constant attention be given to the dam's operation, all liabilities still rest with the dam owners and the State will accept none.

File

#166.04

September 15, 1977

Mr. George M. McGee, Sr. Chairman
N.H. Water Resources Board
37 Pleasant Street
Concord, N.H. 03301

Dear Mr. McGee,

We have been advised by your staff engineer, Mr. Knowlton, that his group has now prepared for the Commission a staff report and recommendations on the Nubanusit Lake levels problem, and that the Commission will presumably act on it at your meeting on Friday, September 16th at Pittsburgh, N.H.

Mr. Knowlton has been kind enough to give us an outline of the guidelines and requirements on administration of the lake levels proposed. Naturally we are crestfallen to find that in these recommendations every single item demanded by our opponents has been granted, and all of the points we have tried so carefully to bring out from the experience of well over a hundred years of careful and safe management of the dam have been ignored.

We will, of course, abide to the best of our ability with your final decisions. We would, however, like to earnestly request at this point one small concession to our difficult position.

Our legal full pond level is at 13.10 feet elevation on the scale and we understand that the staff report will request a level on June 1st of each year at 12.00 feet.

The records of the past eleven years for this date are as follows:

1967	12.90
1969	12.75
1969	12.90
1970	12.30
1971	12.20
1972	12.00
1973	13.00
1974	12.60
1975	12.20
1976	12.45
1977	12.80

We have no record of any complaints concerning these levels for any year other than the present one and we strongly request that you consider revising the bench mark for June 1st from 12.00 to 12.50 feet for the following reasons:

1. The wastage of water during May after the spring runoff to get the level down to 12.00 feet will be considerable, and far beyond any requirements, including generation of power, in the watershed below.

2. This upper six inches of water holds a far larger volume of water than any other half-foot increment of the lake.

This would be a tremendous help to us in carefully budgeting the limited amount of water available to us in the lower lakes to maintain their optimum quality; to somewhat lessen the heavy demand and depreciation of one of the areas great natural assets (Spoonwood Lake); and at the same time to maintain the maximum lower levels of Nubanusit to accomodate the summer population.

We sincerely hope that you will give this slight change in the schedule a great deal of careful consideration. We thoroughly believe it would be the very best for all concerned and would help forestall any future petitions and hearings by the users of Spoonwood, Harrisville, and Skatutakee Lakes.

Very truly yours,

John J. Colony 2d

John and Charles Colony
Harrisville, N.H. 03450

CHESHIRE WOOLENS, INC.
HARRISVILLE, NEW HAMPSHIRE 03450 • (603) 827-3332

3483

Feb.18, 1976

Mr. George M. McGee, Sr. Chairman
Water Resources Board, State of New Hampshire
37 Pleasant Street
Concord, N.H. 03301

Dear Mr. McGee;-

In reply to your comments concerning the dams at Harrisville Pond (#109.08) and Nubanusit Lake (#166.04), and with our helpful conference with your Mr.Bird at the time we made the inspection with him, we have the following comments to make;-

At the Harrisville Dam we have been aware of the slight leakage through the stonework of the dam on the east side. There has been no settlement o f the stonework itself, as this would have shown up in a settlement of the brick factory WALL for which the dam serves as a foundation. We have noted that when the lake is down 1½-2 feet below normal full pond,at which point Mr. Bird made his observations, the leakage entirely subsides, so our problem is evidently due to some small voids in the fill between the canal stonework and the dam stonework, and localized in the top few feet of the fill.

Our plan to remedy this it to drop the lake two feet for a couple of of days after the spring run-off and to hand dig to the voids and puddle with firm hardpan to restore the impermeability. This can certainly be accomplished by the first of July.

As to the overflow weir we will clear out the stones which lie in the channel above the culvert. We will do this very shortly when we have a back-hoe in the area, whichwe expect very soon in conjunction with another job.

As to the Nubanusit Dam we have already talked to the party that will remove the trees from the embankment, and we have advised the nearby cottagers that this is going to have to be done. In regard to thiswe would like to confer with Mr.Bird, when he is again in the area, as to leaving a few of the trees around the western end of the dam near where it reaches the natural grade. This area has a beach which is used by many of the townspeople for swimming and we would like to spare as many of the trees there as possible, however will take down all of the trees that Mr. Bird feels must come down.

The disrepair to the western apron-wall seems to be confined to a concrete topping installed thirty years ago by N.H. Fish and Game to support a fish screen installed by them. We will either trim this up or remove it away from the channel. The dislocation of this topping has caused some damage to the lake level level gauge, which we will remove and reset.Would appreciate your advising if you can furnish any sections of the gauge that may need replacement.

We feel that all of the above projects can be finished by July 1 at the latest, some of them much sooner. We would welcome any comments you might have on our planned procedure.

Very truly yours,

John J. Colony, Jr.

B-18 Charles Colony

NUBANUSIT LAKE

STORM STORAGE CAPACITY REVIEW

I Kennison-Colby: 100 year freq. flow
Q_{100} = 650 cfs peak estimated flow

II SCS: 100 year 6 hr. storm (5 in. precip. with 2.3 in runoff)
Q_p = 1015 cfs

100 year 24 hr. storm (6.1 in. precipitation with 3.2 in runoff)
Q_p = 1415 cfs

III Hurricane 1938:

Produced 10 in. of Precipitation with estimated 6.6 in runoff
Q_p= 2915 cfs

This lake (715 ac. @ full pond) being located in a small watershed (only 6.1 square miles 3904 ac) lends itself well as a runoff storage facility. Only a minimum amount of dam operation should be required even for the management of the estimated 100 year stream flow. The figures above indicate estimated peak flood flows entering the lake. The following is an expansion of these figures into other relationships.

Kennison - Colby:

650 cfs peak, 5790 cfs-hrs = 241 cfs days = 478 ac. ft. or rise of 0.67 ft. of the 715 acre lake.

SCS: 100 year 6 hour storm

1015 cfs peak, 9098.52 cfs-hrs = 380 cfs-days = 750 ac. ft. or rise of 1.05' of the lake

: 100 year 24 hour storm
1415 cfs peak, 12,584.62 cfs-hrs. = 525 cfs - days = 1040 ac. ft. or rise of 1.45' of the lake.

Hurricane - 1938
2915 cfs-peak, 26,020 cfs-hrs = 1084 cfs-days = 2149 ac. ft. or rise of 3.0 ft. on the lake.

In review of the preceeding, it indicates that the storage capacity of the reservoir even at full pond with 2.9' of freeboard could theorically store the 100 year frequency storm without requiring any discharge. In analyzing the supplied data in the files, it appears that for all practical purposes the hurricane of 1938 was temporially stored for the watershed in Nubanusit Lake without any reported damage to the dam as caused by high water. Therefore, the request by the Nubanusit Lake Association of a more stable and gradual drawdown of the lake is possible from the safety aspect against flooding, or breaching of the dam. This assumes, of course, that the dam is structurally sound and the temporary storage will be allowed above the deeded "full pond" rights. If either assumption is not valid, then an alternate management scheme would have to be devised.

January 3, 1975

Mr. John J. Colony, Jr.
Cheshire Mills
Harrisville, New Hampshire

Dear Mr. Colony:

Over the past few months, staff engineers of the Water Resources Board have had the opportunity to review the material you submitted to us regarding the operation of Lake Nubanusit and Spoonwood Pond during the period of January 1973 to August 1974.

The readings submitted were at times sketchy plus covering a period of months which would not allow us the opportunity for a detailed evaluation of your operation. We have also made estimates of the discharge capacity of these lakes and correlated them with drops in lake level.

From this material, we cannot state at this time that your operation was in any way capricious and being dam owners ourselves, we know you are defenseless against unauthorized operation and cannot be held accountable for them. We do, however, question your statement regarding requirement to release water downstream per directives of the Water Supply and Pollution Control Commission since to our knowledge present statutes of the State of New Hampshire relating to the abatement of pollution prohibits the use of stored water to provide dilution as a method of treating polluted waste therefore releases of water for this purpose is not reasonable.

We believe that during periods of low inflow during the summer months, a discharge of 5 cubic feet below Nubanusit Lake would be more reasonable and would meet all common law and riparian rights downstream. The Board is not aware of any legal rights or contract by which you may be bound to discharge in excess of this amount.

To properly evaluate your operation over the next year or more, we request that you notify the Board on a bi-weekly basis of your gate openings and water level so that we may be able to evaluate your operation more thoroughly. We are providing you with reporting cards for this purpose which are self-explanatory. Your operation at Spoonwood Pond could be listed under "Remarks" along with your changes of gate operation.

If you have any questions regarding the above, please contact us at your convenience.

Very truly yours,

George M. McGee, Sr.
Chairman

gmcg/vak:c
encls.

M E M O R A N D U M

DATE: September 10, 1973

FROM: Donald M. Rapoza, Water Resources Engineer

SUBJECT: Inspection of dam at outlet of Nubanusit Lake, Nelson - #166.04

TO: Vernon A. Knowlton, Chief Water Resources Engineer

On September 5, 1973, I inspected the dam at the outlet of Nubanusit Lake in Nelson. Representative Robbins Milbank called this office sometime ago and requested that the dam be inspected because his constituents were inquiring about the safety of the structure.

Inspection Findings

It is my opinion that the dam should be classified as a menace structure because of its location from Harrisville Village and the fact that the only outlet from Nubanusit Lake is gated. If the gates became inoperable for extended periods, the dam could be topped. At the present time, there is no concern for the safety of structure.

Gage Elevation on September 5, 1973 - 9.38 ft.
Lake appears to be approximately 2.0 feet below normal.

No seepage found at toe of earthen embankment.

The visual section of the cut granite stone headwall under the gate house was in good condition. The two walls extending into the lake from the headwall which forms a sluiceway were in poor condition. These walls need repairing or replacement. Debris was found on the trash rack, and the rack did not extend the width of the opening.

Trees and brush on the dam embankment should be removed.

The two gates were opened approximately 5 to 6 inches. Because of the flow, I could not determine the condition of the gates and the condition of the headwall at the gate section.

DMR:js

COPY

February 13-1937

Mr. S. M. Sheldon-

Hancock-

New Hampshire-

Dear Mr-Sheldon:- Here follows a report of the work done at or near the Outlet of Nubanusit Lake, at your request, on this date - You asked to have established the Elevation, above Sea-Level, that is, the Government basis of Levels, of the High Water Mark of the Lake or Pond aforesaid, as such Mark is specifically described in a conveyance by Charles Sheldon to Cheshire Mills, dated March 3-1870, and recorded in Vol-234, Page 139, of Cheshire County Registry-

The basis of my work is the U-S- Geological Survey Bench Mark, which is stamped metal tablet in a boulder near the outlet of the Lake before mentioned- This tablet is marked G-15-1932- and its elevation, as used, is 1388-067, which figure was obtained on the 12th- inst- from the office of Professor Bowler, of New Hampshire University, at Durham-

The markers for the High Water Mark, as referred to in the conveyance aforesaid are Two Irons driven into the southerly side of a boulder not far from the westerly shore-

I find the elevation of these two irons to be 1379-825-feet above the Sea Level Datum mentioned above-

Very truly yours,

Frederick Phillips

B-23

COPY 166.04

H. M. SHELDON
Lumber and Wood

Hancock, N.H.,.....

Vol.234 Page 139 March 3, 1870

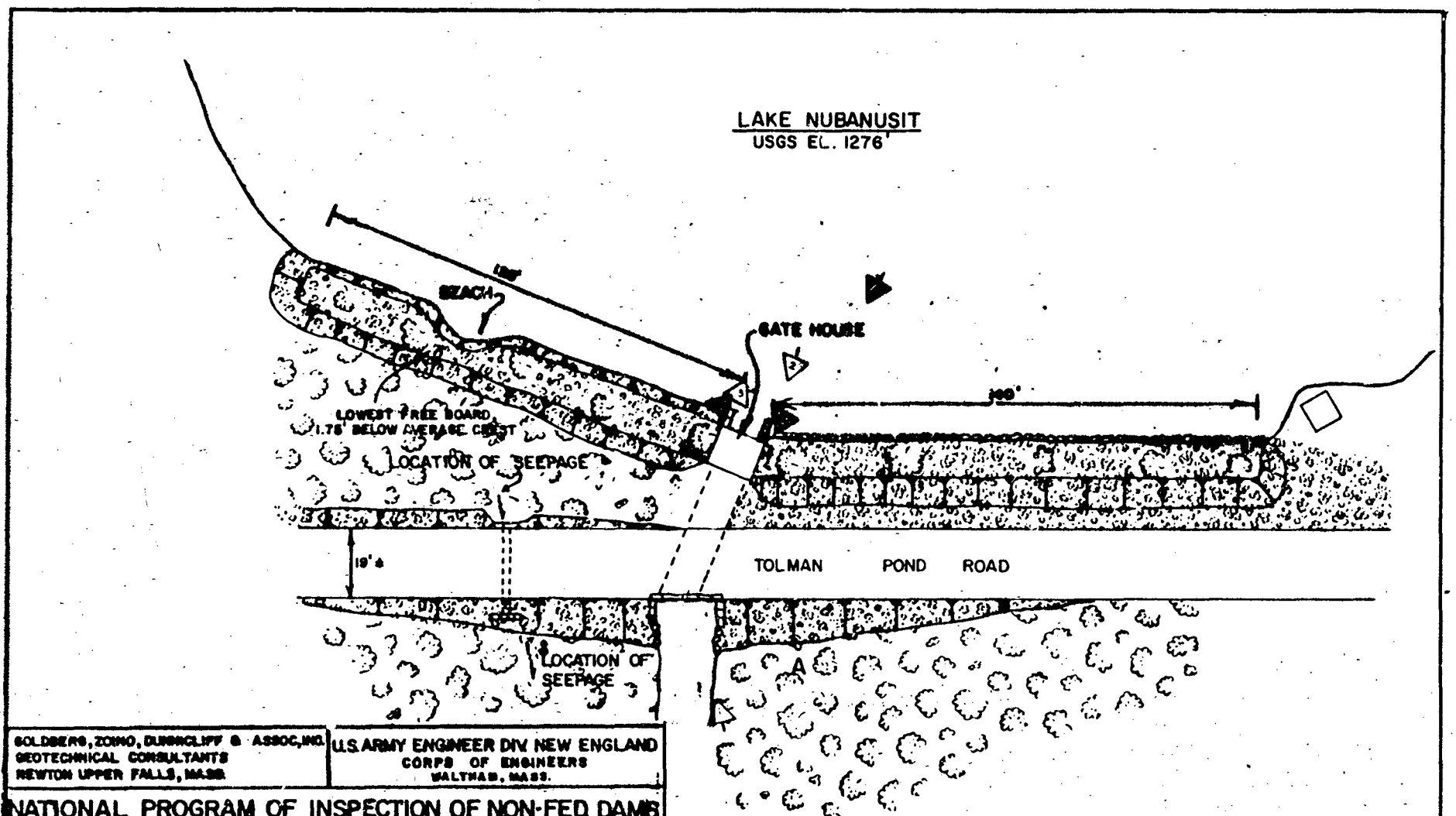
Charles Sheldon to Cheshire Mills

The right and privelege of raising and maintaining at the outlet in Nelson, of Long Pond so called a permanent tight dam and flume, the top of which shall be upon a level with an iron driven into a hole drilled in a stone at their present dam, near the gate house, and two irons driven into holes drilled in a large stone on the shore of said pond, about 26 rods north of the west end of said dam and of flowing by means of such dam so much of the land hereinafter described belonging to me, as will be flowed in consequence of erecting and maintaining said dam.

I also give grant bargain sell and convey the right and privilege at any time of drawing off the water from said lands untill the surface of said pond shall be eleven feet and ten inches below the irons above mentioned.

APPENDIX C

SELECTED PHOTOGRAPHS



GOLDBERG, ZOINO, DUNNCLIFF & ASSOC, INC.
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LOCATION AND ORIENTATION OF PHOTOS

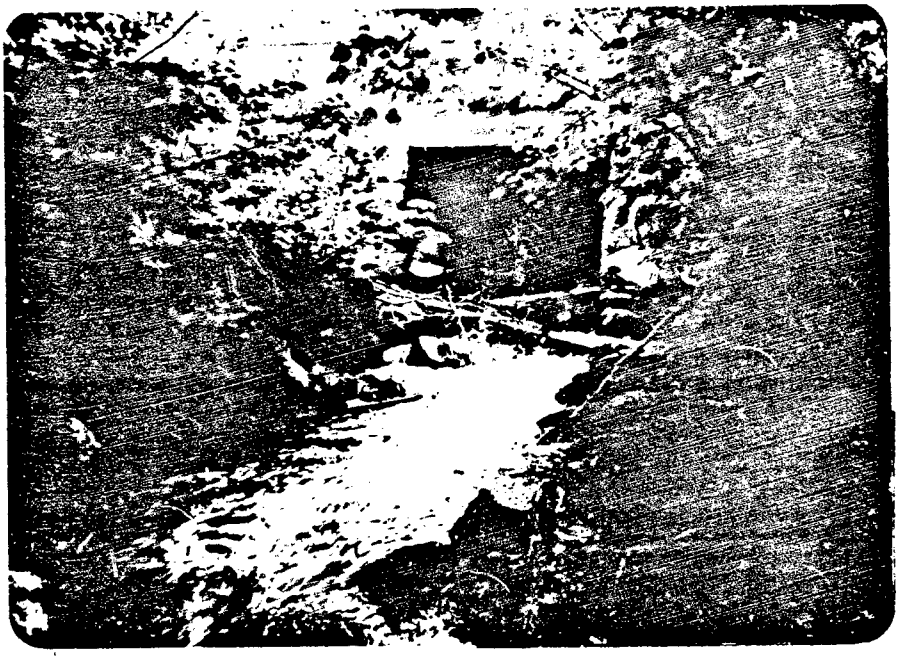
LAKE NUBANUSIT — NEW HAMPSHIRE

SCALE 1" = 40'

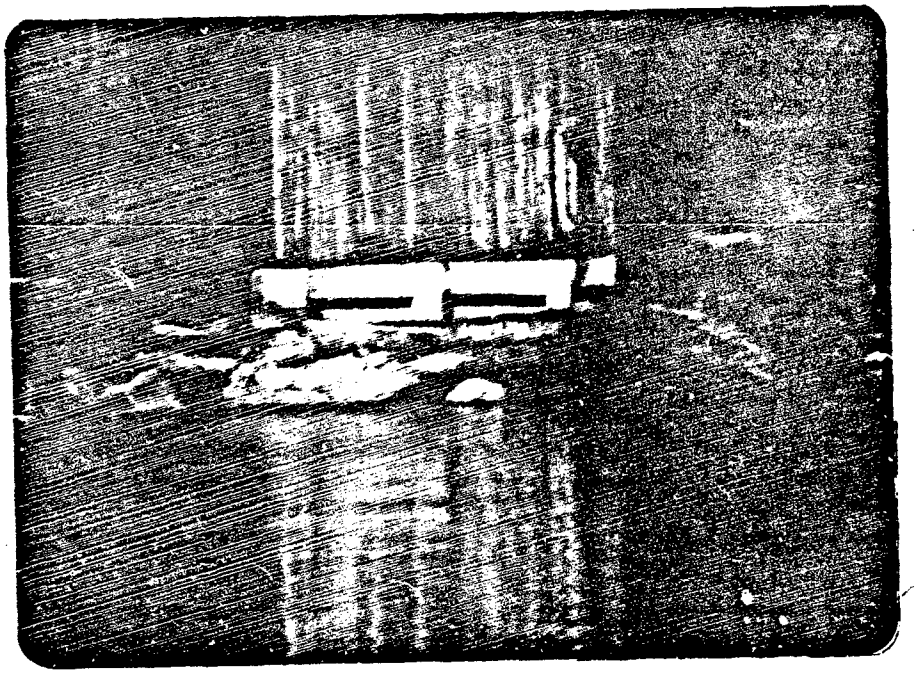
DATE JULY 1978

C-2

FILE No. 2067



1. View of outlet area and downstream channel



2. Detail of gatehouse inlet from upstream

3. Detail of photo 1 from right side of gatehouse

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

FOR

NUBANUSIT LAKE DAM

- SCALE -

0 1/2 1 2 miles

FROM: USGS MONADNOCK, N.H. QUADRANGLE MAP

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC.
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

DRAINAGE AREA

NUBANUSIT LAKE — NEW HAMPSHIRE

FILE No. 2067

SCALE AS SHOWN

DATE JULY 1978

Dams 148 | Nubanusit Lake | TCG | 7-17-78 | 1 of

Size Classification = Intermediate

Hazard Classification = Significant

The town of Harrisville is in the floodplain downstream of Harrisville Pond, which is downstream of Nubanusit Lake.

SPILLWAY DESIGN FLOOD:

1/2 PMF to PMF

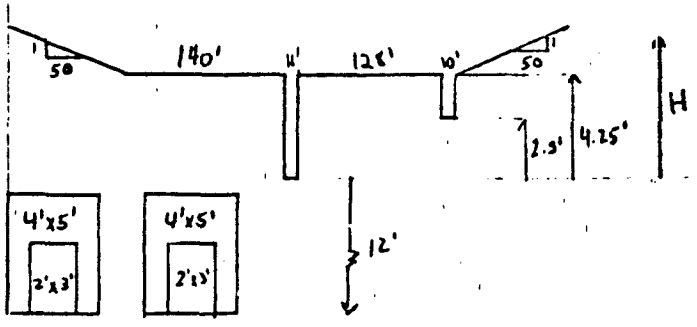
FOR PMF, COE rolling curve with 6.10 sq. mi. gives 1800 cfs/mi². To account for the effects of Spoonwood Pond upstream, use 1500 (cfs/mi²)

→ PMF = 6.1 (1500) = 9150 cfs

1/2 PMF = 4575 cfs

Since hazard is slightly biased to the high side of significant, use 3000 cfs for SDF.

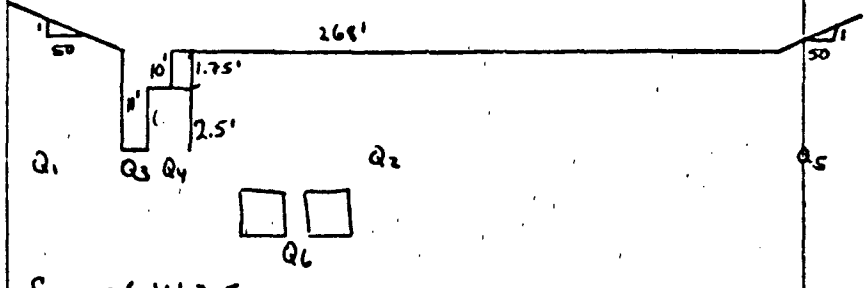
DAMS 148 | Nubanusit LAKE | TCG | 7-19-78 | 3/



NOT TO SCALE

Assume the 2'x3' gates open at all times. Assume the 4'x5' gates open when the water surface hits the road at 2.5'.

The dam could be simplified to this:



for OL HL 2.5

$Q_3 = 2.0(11) H^{3/2}$

$Q_6 = .59(12) \sqrt{2g}\,(H+12.0)$

Underflow sluice gate, Rouse Engineering Hydraulics, p. 50

Dams 149 | Nubanusit lake | TCG 7-19-79 | 4 of

FOR $2.5 < H < 4.25$

$Q_3 = 3.0\,(11)\,H^{3/2}$

$Q_6 = .59\,(40)\,(\sqrt{2g\,(H+12)})$

$Q_4 = 3.0\,(10)\,(H-2.5)^{3/2}$

FOR $H > 4.25$

$Q_1 = Q_5 = 2.8\,(50(H-4.25))\,(.5(H-4.25))^{3/2}$

$Q_2 = 2.8\,(268)\,(H-4.25)^{3/2}$

$Q_3 = 3.0\,(11)\,H^{3/2}$

$Q_4 = 3.0\,(10)\,(H-2.5)^{3/2}$

$Q_6 = .59\,(40)\,\sqrt{2g\,(H+12.0)}$

If the 4'x5' gates are not opened, the formulae are the same except that:

$2.5 < H < 4.25$

$Q_6 = .59(12)\,(\sqrt{2g\,(H+12)})$

$H > 4.25$

$Q_6 = .59(12)\,\sqrt{2g\,(H+12)}$

```
LIST
100 REM stage discharge calc for nubanusit lake dam job 148 (4'x5' gates open at 25')
110 PAGE
120 E=1.5
130 PRINT "TOTAL DISCHARGE FROM NUBANUSIT LAKE DAM AS FUNC OF HEAD"
140 PRINT USING 150:
150 IMAGE // 2T"HEAD"30T"DISCHARGE"
160 PRINT USING 170:
170 IMAGE 10T"TOTAL      Q1    Q2    Q3    Q4    Q5    Q6"
180 FOR H=0.25 TO 7.5 STEP 0.25
190 Q6=0.59*12*(2*32.2*(H+12))↑0.5
200 Q3=3*11*H↑E
210 Q1=0
220 Q2=0
230 Q4=0
240 Q5=0
250 IF H<=2.5 THEN 310
260 Q4=3*10*(H-2.5)↑E
265 Q6=0.59*40*(2*32.2*(H+12))↑0.5
270 IF H<=4.25 THEN 310
280 Q1=2.8*(50*(H-4.25))*(0.5*(H-4.25))↑E
290 Q5=Q1
300 Q2=2.8*268*(H-4.25)↑E
310 Q7=Q1+Q2+Q3+Q4+Q5+Q6
320 PRINT USING 330:H,Q7,Q1,Q2,Q3,Q4,Q5,Q6
330 IMAGE 1T,2D.2D,8D,9D,6D,6D,6D,6D,6D
340 NEXT H
350 END
```

TOTAL DISCHARGE FROM NUBANUSIT LAKE DAM AS FUNC OF HEAD (4'x5' gates open at 2.5')

HEAD	DISCHARGE						
	TOTAL	Q1	Q2	Q3	Q4	Q5	Q6
0.25	203	0	0	4	0	0	199
0.50	213	0	0	12	0	0	201
0.75	224	0	0	21	0	0	203
1.00	238	0	0	33	0	0	205
1.25	253	0	0	46	0	0	207
1.50	269	0	0	61	0	0	209
1.75	287	0	0	76	0	0	211
2.00	306	0	0	93	0	0	213
2.25	326	0	0	111	0	0	214
2.50	347	0	0	130	0	0	216
2.75	882	0	0	150	4	0	727
3.00	916	0	0	171	11	0	734
3.25	952	0	0	193	19	0	740
3.50	992	0	0	216	30	0	746
3.75	1033	0	0	240	42	0	752
4.00	1077	0	0	264	55	0	758
4.25	1122	0	0	289	69	0	763
4.50	1266	2	94	315	85	2	769
4.75	1501	9	265	342	101	9	775
5.00	1804	24	487	369	119	24	781
5.25	2178	49	758	397	137	49	787
5.50	2595	86	1049	426	156	86	792
5.75	3080	136	1379	455	176	136	798
6.00	3623	201	1737	485	196	201	804
6.25	4225	280	2122	516	218	280	809
6.50	4886	376	2533	547	240	376	815
6.75	5606	489	2966	579	263	489	820
7.00	6387	621	3422	611	286	621	826
7.25	7228	772	3899	644	311	772	831
7.50	8131	943	4397	678	335	943	836

```
LIST
100 REM stage discharge calc for nubanusit lake dam job 148 (4' x 5' gates do not open)
110 PAGE
120 E=1.5
130 PRINT "TOTAL DISCHARGE FROM NUBANUSIT LAKE DAM AS FUNC OF HEAD"
140 PRINT USING 150:
150 IMAGE // 2T"HEAD"30T"DISCHARGE"
160 PRINT USING 170:
170 IMAGE 10T"TOTAL      Q1    Q2    Q3    Q4    Q5    Q6"
180 FOR H=0.5 TO 7.75 STEP 0.25
190 Q6=0.59*12*(2*32.2*(H+12))↑0.5
200 Q3=3*11*H↑E
210 Q1=0
220 Q2=0
230 Q4=0
240 Q5=0
250 IF H<=2.5 THEN 310
260 Q4=3*10*(H-2.5)↑E
270 IF H<=4.25 THEN 310
280 Q1=2.8*(50*(H-4.25))*(0.5*(H-4.25))↑E
290 Q5=Q1
300 Q2=2.8*268*(H-4.25)↑E
310 Q7=Q1+Q2+Q3+Q4+Q5+Q6
320 PRINT USING 330:H,Q7,Q1,Q2,Q3,Q4,Q5,Q6
330 IMAGE 1T,2D.2D,8D,9D,6D,6D,6D,6D,6D
340 NEXT H
350 END
```

TOTAL DISCHARGE FROM NUBANUSIT LAKE DAM AS FUNC OF HEAD (4'x5' gates do not open)

HEAD	DISCHARGE						
	TOTAL	Q1	Q2	Q3	Q4	Q5	Q6
0.50	213	0	0	12	0	0	201
0.75	224	0	0	21	0	0	203
1.00	238	0	0	33	0	0	205
1.25	253	0	0	46	0	0	207
1.50	269	0	0	61	0	0	209
1.75	287	0	0	76	0	0	211
2.00	306	0	0	93	0	0	213
2.25	326	0	0	111	0	0	214
2.50	347	0	0	130	0	0	216
2.75	372	0	0	150	4	0	218
3.00	402	0	0	171	11	0	220
3.25	435	0	0	193	19	0	222
3.50	470	0	0	216	30	0	224
3.75	507	0	0	240	42	0	225
4.00	546	0	0	264	55	0	227
4.25	588	0	0	289	69	0	229
4.50	728	2	94	315	85	2	231
4.75	958	9	265	342	101	9	233
5.00	1257	24	487	369	119	24	234
5.25	1619	49	750	397	137	49	236
5.50	2041	86	1049	426	156	86	238
5.75	2522	136	1379	455	176	136	239
6.00	3061	201	1737	485	196	201	241
6.25	3659	280	2122	516	218	280	243
6.50	4316	376	2533	547	240	376	244
6.75	5032	489	2966	579	263	489	246
7.00	5809	621	3422	611	286	621	248
7.25	6646	772	3899	644	311	772	249
7.50	7546	943	4397	678	335	943	251
7.75	8508	1134	4914	712	361	1134	252

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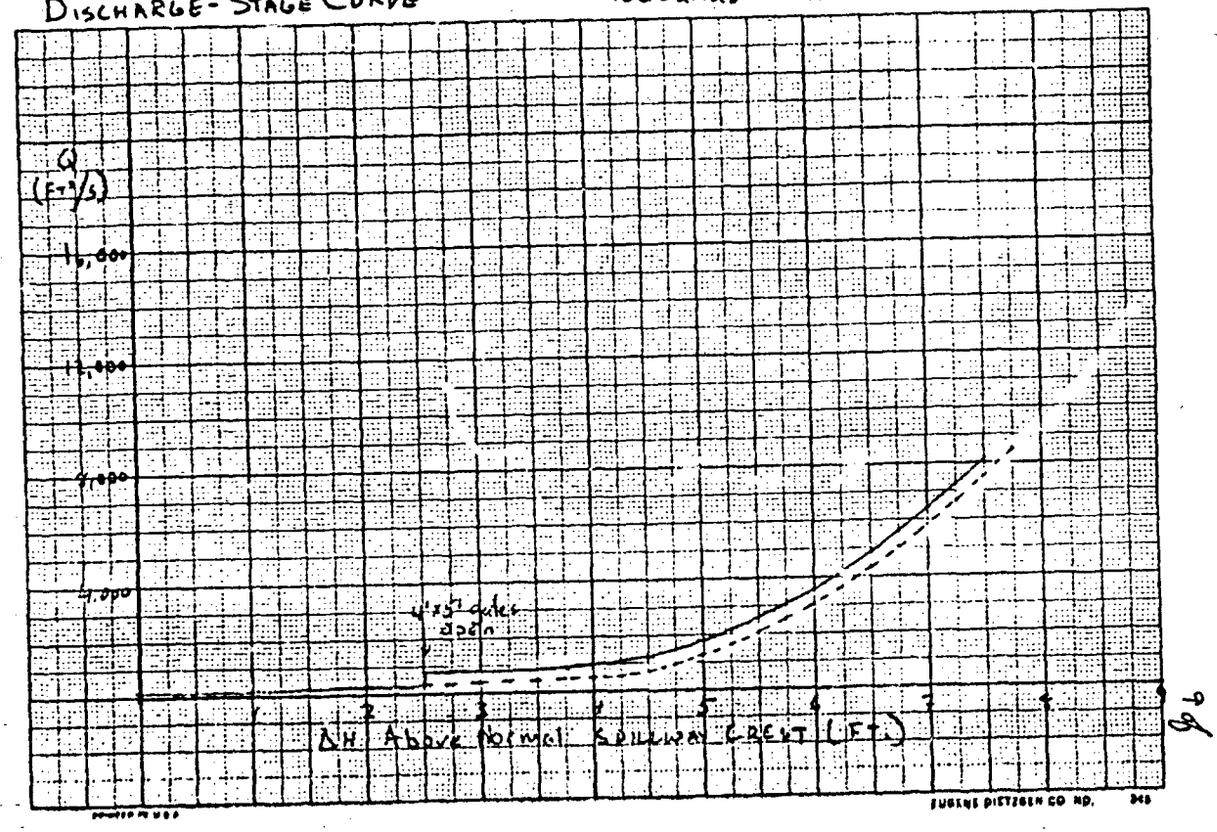
TLG
7-15-78

DISCHARGE-STAGE CURVE — Nubanusit Lake



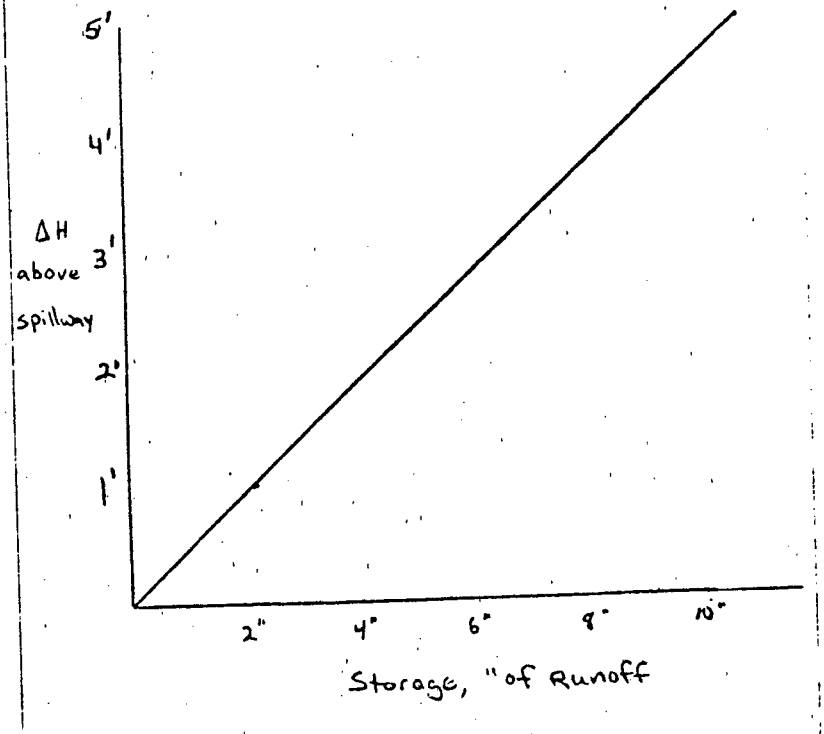
Dams 149 Nubanusit Lake TLG 7-17-78 10g

STORAGE - STAGE RELATIONSHIP

Surface area of pond at normal level = 715 acres
= 1.117 sq. mi.

1" of runoff $\longrightarrow \frac{1"\,(3979\,ac)}{715\,acres} = 5.565"$ rise in water surface

1' of rise = 2.156" runoff
use 1' → 2.16" r.o.



STORAGE - STAGE CURVE

Nubanusit Lake

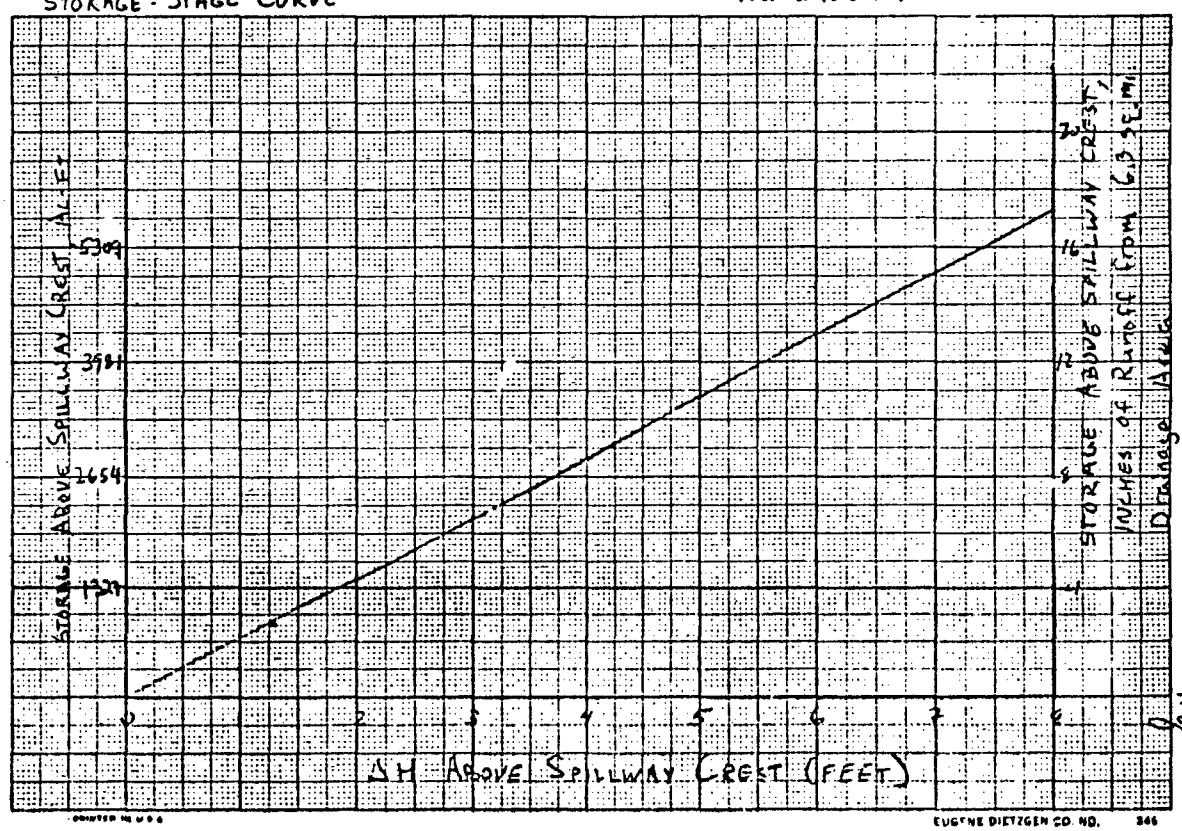


fig 11

DAMS 148 | NUBANUSIT LAKE | TC6 7-20-78 RJ

Reduction in flow due to storage:

Assume total storm volume = 19"

$Q_{p_2} = Q_{p_1}\left(1 - \frac{STOR\,1}{19}\right)$.

(1). Assume Lake starts at 11.5', 4'x5' gates open at H=2.5'

Q_{p_1} = 8000 cfs → H = 7.46'

STOR = (7.46+.5)(2.16) = 17.19"

$Q_{p_2} = 8000\left(1 - \frac{17.19}{19}\right) = 762$ cfs

H_2 = 2.51' → STOR = (3.01)(2.16) = 6.50"

$Q_{p_3} = 8000\left(1 - \frac{6.50}{19}\right) = 5263$ cfs → H_3 = 6.63'

STOR = 7.13(2.16) = 15.40"

$Q_{p_4} = 8000\left(1 - \frac{15.40}{19}\right) = 1516$ → H_4 = 4.76'

STOR = 5.26(2.16) = 11.36"

Use Ave. of STOR 3 & STOR 4 = $\frac{15.40+11.36}{2} = 13.38$"

$Q_p = 8000\left(1 - \frac{13.38}{19}\right) = 2366$ cfs, which gives H = 5.37', or 1.12' above the dam crest

(2). Assume Lake starts at 12.5', 4'x5' gates open at H=2.5'

Q_{p_1} = 8000 cfs → H = 7.46'

STOR = (7.46-.5)(2.16) = 15.03

$Q_{p_2} = 8000\left(1 - \frac{15.03}{19}\right) = 1672$

DAMS 148 Nubanusit Lake TCG 7-20-78 13

H_2 = 4.89' → STOR = (4.39)(2.16) = 9.48"

$Q_{p3} = 8000\left(1 - \frac{9.48}{19}\right) = 4008$ → H = 6.16' → STOR = 12.23"

$Q_{p4} = 8000\left(1 - \frac{12.23}{19}\right) = 2851$ → H = 5.63' → STOR = 11.08"

USE AVE of 3 & 4: STOR = $\frac{12.23 + 11.08}{2} = 11.655$

$Q_p = 8000\left(1 - \frac{11.655}{19}\right) = 3093$ cfs → H = 5.76', or 1.51' over the dam crest.

③. ASSUME Dam Starts at 11.5', 4'x5' gates do not open.

$Q_{p1} = 8000$ → H: 7.62' → STOR = (H+1.5)(2.16) = 17.54"

$Q_{p2} = 8000\left(1 - \frac{17.54}{19}\right) = 615$ → H = 4.30' → STOR = 10.37

$Q_{p3} = 8000\left(1 - \frac{10.37}{19}\right) = 3634$ → H = 6.24' → STOR = 14.56

$Q_{p4} = 8000\left(1 - \frac{14.56}{19}\right) = 1869$ → H = 5.40' → STOR = 12.74

$Q_{p5} = 8000\left(1 - \frac{12.74}{19}\right) = 2636$ → H = 5.80' → STOR = 13.61

USE STOR = $\frac{12.74 + 13.61}{2} = 13.175$

$Q_p = 8000\left(1 - \frac{13.175}{19}\right) = 2453$ → H = 5.71', or 1.46' over the dam crest.

④ ASSUME DAM STARTS AT 12.5', 4'x5' gates do not open.

$Q_{p1} = 8000$ → H = 7.62' → STOR = (H-.5)(2.16) = 15.38

$Q_{p2} = 8000\left(1 - \frac{15.38}{19}\right) = 1524$ → H = 5.19' → STOR = 10.13

$Q_{p3} = 8000\left(1 - \frac{10.13}{19}\right) = 3735$ → H = 6.47' → STOR = 12.90

$Q_{p4} = 8000\left(1 - \frac{12.9}{19}\right) = 2568$ → H = 5.76' → STOR = 11.36

$Q_{p5} = 8000\left(1 - \frac{11.36}{19}\right) = 3217$ → H = 6.07' → STOR = 12.03

Dams 148 Nubanusit Lake TCG 7-21-78 14f

USE STOR = $\frac{11.36+12.03}{2}$ = 11.695

$Q_P = 8000\left(1-\frac{11.695}{19}\right)^2$ = 3076cfs → H = 6.01',

or 1.76' above the dam crest.

DAMS 148 Nubanusit Lake TLG 7-20-78 1 of

Calculation of Estimated Downstream Dam Failure Flood Stages - Based on COE "Rule of Thumb" Guidance, April, 1978

STEP 1: Reservoir Storage at time of failure. ASSUME FAILURE OCCURS when Dam crest is overtopped.

Storage = Normal storage + surcharge
= 4600 + 4.25(715)
= 7640 acre-ft.

STEP 2: Peak failure outflow,

$$Q_{p_1} = 8/27\, W_b \sqrt{g}\, Y_o^{3/2}$$

$W_b < 40\%$ (width) = .4(289) = 115.6'

Use W_b = 100 ft.

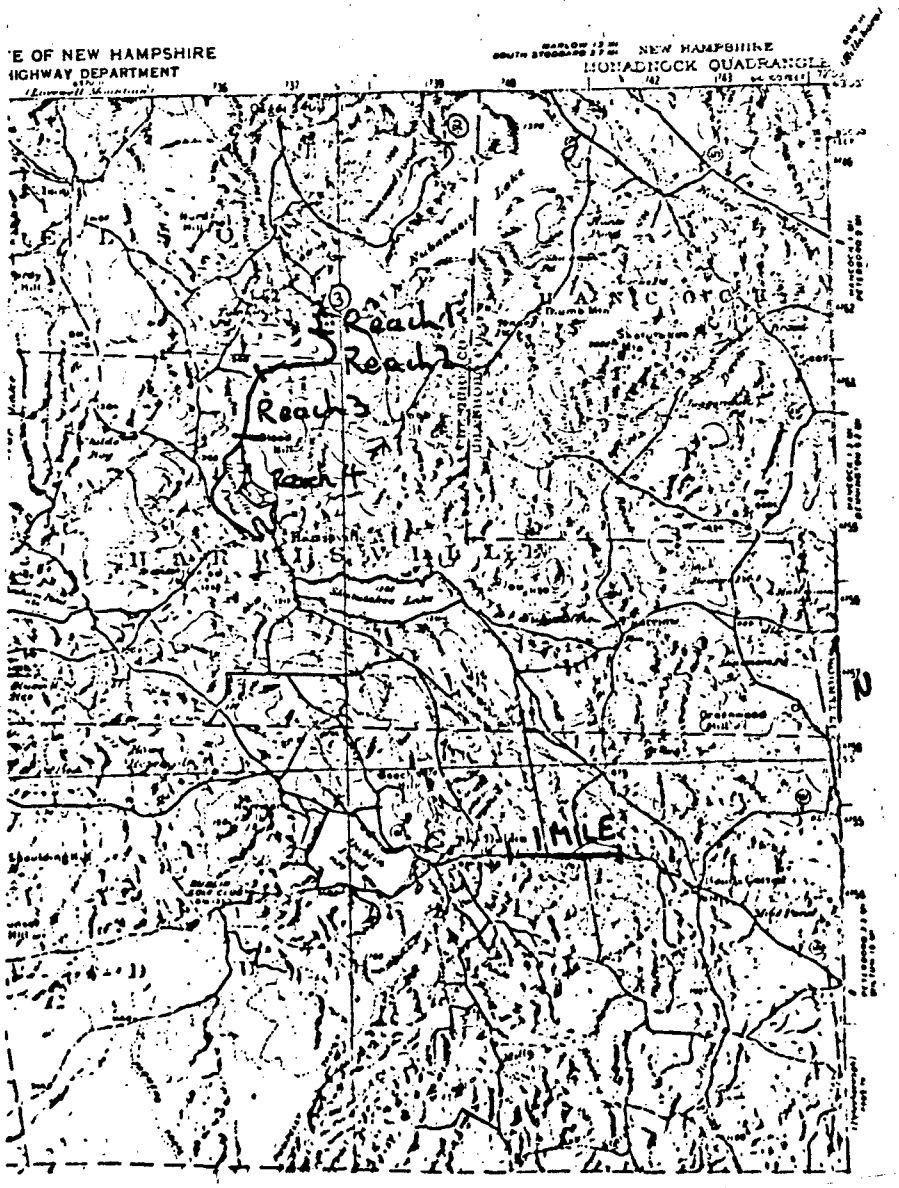
Y_o = 12 + 4.25 = 16.25

$$Q_{p_1} = 8/27\,(100)\sqrt{32.2}\,(16.25)^{1.5}$$
$$= 11{,}014 \text{ cfs} \rightarrow 11{,}000 \text{ cfs}$$

STEP 3: Develop Stage-Discharge Routing for downstream reaches.

Assumed cross-sections for the downstream reaches shown on the USGS topo sheet are plotted on the attached sheet.

Computer output tables of Stage-Discharge relationships are attached.


E OF NEW HAMPSHIRE
IGHWAY DEPARTMENT
NEW HAMPSHIRE
MONADNOCK QUADRANGLE
Reach 1
Reach 2
Reach 3
Reach 4
1 MILE

Dams 149 Nubanusit Lake TCG 7-17-87

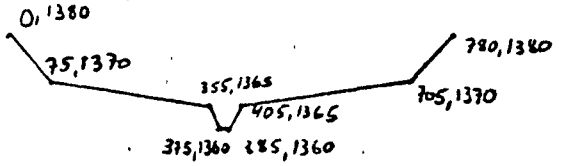
Reach 1- Dam to ponded area

L = 1200'

S = $\frac{1376-1351}{1200}$

= .02083

n = .05



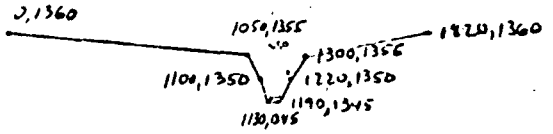
Reach 2- Ponded Area

L = 5250'

S = $\frac{.6}{5250}$

= .00114

n = .045



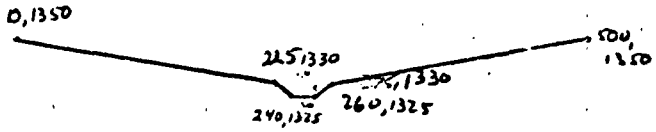
Reach 3- Ponded Area to Harrisville Pond

L = 2350'

S = $\frac{1345-1318}{2350}$

= .0115

n = .05



DEPTH	ELEV	AREA	WPER	HYD-R	AR2/3	Q
0.0	1360.0	0.0	0.0	0.0	0.0	0.0
1.0	1361.0	14.0	18.2	0.8	11.7	50.5
2.0	1362.0	36.0	26.5	1.4	44.2	190.0
3.0	1363.0	66.0	34.7	1.9	101.3	435.5
4.0	1364.0	104.0	43.0	2.4	187.5	806.4
5.0	1365.0	150.0	51.2	2.9	307.1	1320.8
6.0	1366.0	258.0	167.2	1.5	344.5	1481.7
7.0	1367.0	482.0	283.3	1.7	687.1	2955.2
8.0	1368.0	822.0	399.3	2.1	1330.6	5722.7
9.0	1369.0	1278.0	515.3	2.5	2342.3	10074.9
10.0	1370.0	1850.0	631.3	2.9	3789.7	16299.4
11.0	1371.0	2487.5	646.5	3.8	6111.0	26282.8
12.0	1372.0	3140.0	661.6	4.7	8872.6	38160.4
13.0	1373.0	3807.5	676.7	5.6	12051.6	51833.0
14.0	1374.0	4490.0	691.8	6.5	15631.7	67230.8
15.0	1375.0	5187.5	707.0	7.3	19601.1	84302.6
16.0	1376.0	5900.0	722.1	8.2	23950.8	103010.4
17.0	1377.0	6627.5	737.2	9.0	28674.3	123325.6
18.0	1378.0	7370.0	752.4	9.8	33766.4	145226.5
19.0	1379.0	8127.5	767.5	10.6	39223.5	168697.0
20.0	1380.0	8900.0	782.6	11.4	45042.8	193725.3

NUBANUSIT LAKE - REACH 1

DEPTH	ELEV	AREA	WPER	HYD-R	AR2/3	Q
0.0	1345.0	0.0	0.0	0.0	0.0	0.0
0.5	1345.5	31.5	66.1	0.5	19.2	21.5
1.0	1346.0	66.0	72.2	0.9	62.2	69.5
1.5	1346.5	103.5	78.2	1.3	124.7	139.4
2.0	1347.0	144.0	84.3	1.7	205.8	230.0
2.5	1347.5	187.5	90.4	2.1	305.0	341.0
3.0	1348.0	234.0	96.5	2.4	422.5	472.3
3.5	1348.5	283.5	102.6	2.8	558.5	624.4
4.0	1349.0	336.0	108.7	3.1	713.4	797.6
4.5	1349.5	391.5	114.7	3.4	887.7	992.4
5.0	1350.0	450.0	120.8	3.7	1081.7	1209.3
5.5	1350.5	513.3	133.9	3.8	1257.8	1406.2
6.0	1351.0	583.0	146.9	4.0	1462.0	1634.5
6.5	1351.5	659.3	159.9	4.1	1695.5	1895.5
7.0	1352.0	742.0	173.0	4.3	1959.0	2190.9
7.5	1352.5	831.3	186.0	4.5	2256.2	2522.4
8.0	1353.0	927.0	199.1	4.7	2586.3	2891.4
8.5	1353.5	1029.3	212.1	4.9	2951.6	3299.7
9.0	1354.0	1138.0	225.2	5.1	3353.4	3749.0
9.5	1354.5	1253.3	238.2	5.3	3793.3	4240.8
10.0	1355.0	1375.0	251.2	5.5	4272.7	4776.7
10.5	1355.5	1539.3	408.2	3.8	3730.5	4170.5
11.0	1356.0	1782.0	565.2	3.2	3832.9	4285.0
11.5	1356.5	2103.3	722.2	2.9	4290.6	4796.7
12.0	1357.0	2503.0	879.2	2.8	5029.4	5622.6
12.5	1357.5	2981.3	1036.3	2.9	6032.6	6744.2
13.0	1358.0	3538.0	1193.3	3.0	7304.6	8166.3
13.5	1358.5	4173.3	1350.3	3.1	8858.1	9903.1
14.0	1359.0	4887.0	1507.3	3.2	10709.8	11973.1
14.5	1359.5	5679.3	1664.3	3.4	12878.0	14397.1

NUBANUSIT LAKE - REACH 2

DEPTH	ELEV	AREA	WPER	HYD-R	AR2/3	Q
0.0	1325.0	0.0	0.0	0.0	0.0	0.0
1.0	1326.0	23.0	26.3	0.9	21.0	67.2
2.0	1327.0	52.0	32.6	1.6	70.9	226.7
3.0	1328.0	87.0	39.0	2.2	148.6	475.0
4.0	1329.0	128.0	45.3	2.8	255.9	817.9
5.0	1330.0	175.0	51.6	3.4	395.1	1262.5
6.0	1331.0	236.3	74.2	3.2	511.5	1634.5
7.0	1332.0	320.0	96.8	3.3	710.4	2270.2
8.0	1333.0	426.3	119.4	3.6	996.1	3183.3
9.0	1334.0	555.0	142.0	3.9	1377.9	4403.2
10.0	1335.0	706.3	164.6	4.3	1866.0	5963.2
11.0	1336.0	880.0	187.2	4.7	2471.1	7896.9
12.0	1337.0	1076.3	209.7	5.1	3203.6	10237.6
13.0	1338.0	1295.0	232.3	5.6	4073.4	13017.4
14.0	1339.0	1536.3	254.9	6.0	5090.5	16267.6
15.0	1340.0	1800.0	277.5	6.5	6264.3	20018.8
16.0	1341.0	2086.3	300.1	7.0	7604.1	24300.4
17.0	1342.0	2395.0	322.7	7.4	9118.9	29141.4
18.0	1343.0	2726.3	345.3	7.9	10817.6	34569.7
19.0	1344.0	3080.0	367.9	8.4	12708.7	40613.8
20.0	1345.0	3456.3	390.5	8.9	14800.6	47298.1
21.0	1346.0	3855.0	413.0	9.3	17101.5	54651.2
22.0	1347.0	4276.3	435.6	9.8	19619.6	62698.2
23.0	1348.0	4720.0	458.2	10.3	22362.7	71464.5
24.0	1349.0	5186.3	480.8	10.8	25338.8	80974.9
25.0	1350.0	5675.0	503.4	11.3	28555.3	91254.0

NUBANUSIT LAKE - REACH 3

DAMS 148 Nubanusit Lake TCG 7-20-78 21 of

STEP 4: CALCULATIONS

Reach 1 : Q_{p_1} = 11,000 cfs

H = 9.15'

AREA = 1364 ft²

$V_1 = L \times A = \frac{1200(1364)}{43560} = 37.6$ acres

$Q_{p_2T} = Q_{p_1}\left(1 - \frac{37.6}{7640}\right) = 10,946$ cfs

H = 9.14'

AREA = 1358 ft²

V_2 = 37.4 ac-ft.

Vave = 37.5 ac-ft

$Q_{p_2} = 11,000\left(1 - \frac{37.5}{7640}\right) = 10,950$ cfs

Reach 2:

Q_{p_1} = 10,950

H = 13.75

Area = 4530 ft²

$V_1 = \frac{5250(4530)}{43,560} = 546$ acre-ft

$Q_{p_2T} = 10,950\left(1 - \frac{546}{7640}\right) = 10,170$

H = 13.56 ft

Area = 4259 ft²

$V_2 = \frac{5250(4259)}{43,560} = 513$ acre-ft

Vave = 529.5 ac-ft

Dams 148 Nubanusit Lake TCC 7-20-78 22 of

$Q_{p2} = 10{,}950\left(1 - \frac{529.5}{7640}\right) = 10{,}190$ cfs

Reach 3: $Q_{p1} = 10{,}190$ cfs

$H = 11.95$ ft

Area = 1072 ft

$V_1 = \frac{1072(7350)}{43560} = 57.8$ ac-ft

$Q_{p2T} = 10{,}190\left(1 - \frac{57.8}{7640}\right) = 10{,}110$

$H = 11.95$

Area = 1066.5

$V_2 = 57.5$ ac-ft

$V_{ave} = 57.65$ ac-ft

$Q_{p2} = 10{,}190\left(1 - \frac{57.65}{7640}\right) = 10{,}110$ cfs

So the peak flow entering Harrisville Pond is 10,110 cfs. The total volume entering Harrisville pond is 7640 ac-ft → 332,798,400 ft³

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST	STATE	COUNTY	CONGR (SEN)	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY | MO | YR
NH	339	NED	NH	005	02				NUBANUSIT LAKE DAM	4258.4	7200.2	08SEP78

POPULAR NAME	NAME OF IMPOUNDMENT
	NUBANUSIT LAKE

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	NUBANUSIT BROOK	HARRISVILLE	2	300

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT)	HYDRAULIC HEIGHT	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT)	DIST	OWN	FED R	PRV/FED	BCB A	VER/DATE
EMBKPC	1861	SRH	17	16	7640	4600	NED	N	N	N	N	17AUG78

REMARKS

O/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY U/C	D [illegible]	VOLUME OF DAM (CY)	POWER CAPACITY STAT (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO	LENGTH	HEIGHT	LENGTH	WIDTH	LENGTH	HEIGHT	LENGTH	WIDTH	LENGTH	WIDTH
3	279	U	11		2500													

OWNER	ENGINEERING BY	CONSTRUCTION BY
JOHN J COLONY JR		

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NH WATER RES BD	NH WATER RES BD	NH WATER RES BD	NH WATER RES BD

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION
GOLDBERG ZOINO DUNNICLIFF + ASSOC	18JUL78	PL 92-367

REMARKS

END

FILMED

8-85

DTIC